



SMITHSONIAN CONTRIBUTIONS TO KNOWLEDGE.

# TIDAL OBSERVATIONS

IN THE

## ARCTIC SEAS.

BY

ELISHA KENT KANE, M.D., U.S.N.

MADE DURING THE SECOND GRINNELL EXPEDITION IN SEARCH OF SIR JOHN FRANKLIN,  
IN 1853, 1854, AND 1855, AT VAN RENSSELAER HARBOR.

REDUCED AND DISCUSSED,

BY

CHARLES A. SCHOTT.

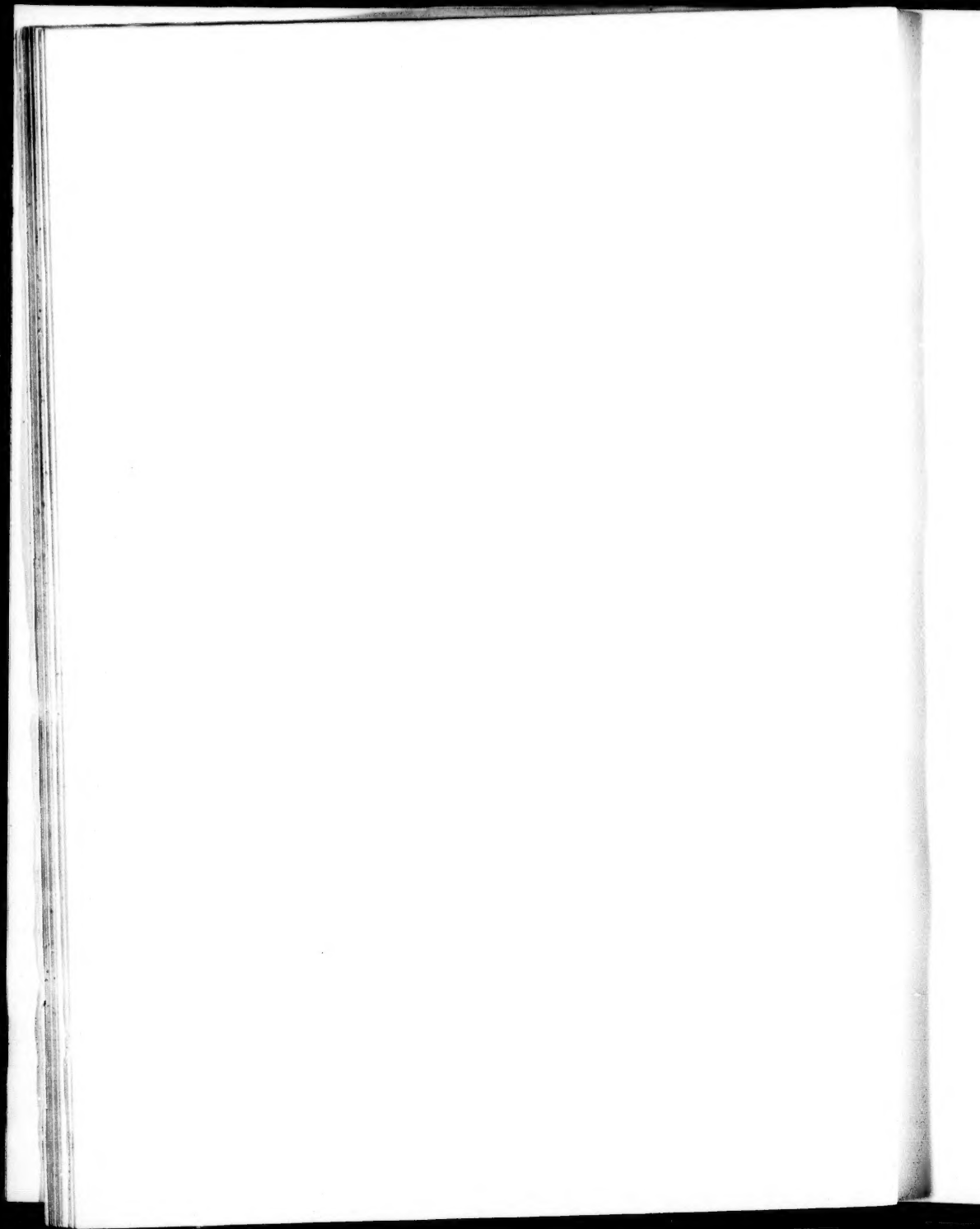
ASSISTANT U. S. COAST SURVEY.

[ACCEPTED FOR PUBLICATION, JULY, 1860.]

COLLINS, PRINTER.  
PHILADELPHIA.

# CONTENTS.

|                                                                                                                     | PAGE |
|---------------------------------------------------------------------------------------------------------------------|------|
| INTRODUCTORY LETTER . . . . .                                                                                       | v    |
| Explanatory and introductory remarks . . . . .                                                                      | 1    |
| Record of tidal observations at Van Rensselaer Harbor, 1853-4-5 . . . . .                                           | 5    |
| Discussion of half-monthly inequality in time and height . . . . .                                                  | 67   |
| Effect of changes of the moon's declination and parallax . . . . .                                                  | 72   |
| Discussion of the diurnal inequality in height and time . . . . .                                                   | 74   |
| Investigation of the form of the tidal wave . . . . .                                                               | 78   |
| Note on the effect of wind on the tides . . . . .                                                                   | 81   |
| Note on the progress of the tidal wave and depth of the sea . . . . .                                               | 81   |
| Record of soundings . . . . .                                                                                       | 82   |
| APPENDIX—containing a tidal record at Wolstenholm Sound, Commander Saunders, 1849-50,<br>with four plates . . . . . | 83   |



## INTRODUCTORY LETTER.

WASHINGTON, July 4th. 1860

PROFESSOR JOSEPH HENRY, LL.D.,

*Secretary of the Smithsonian Institution:*

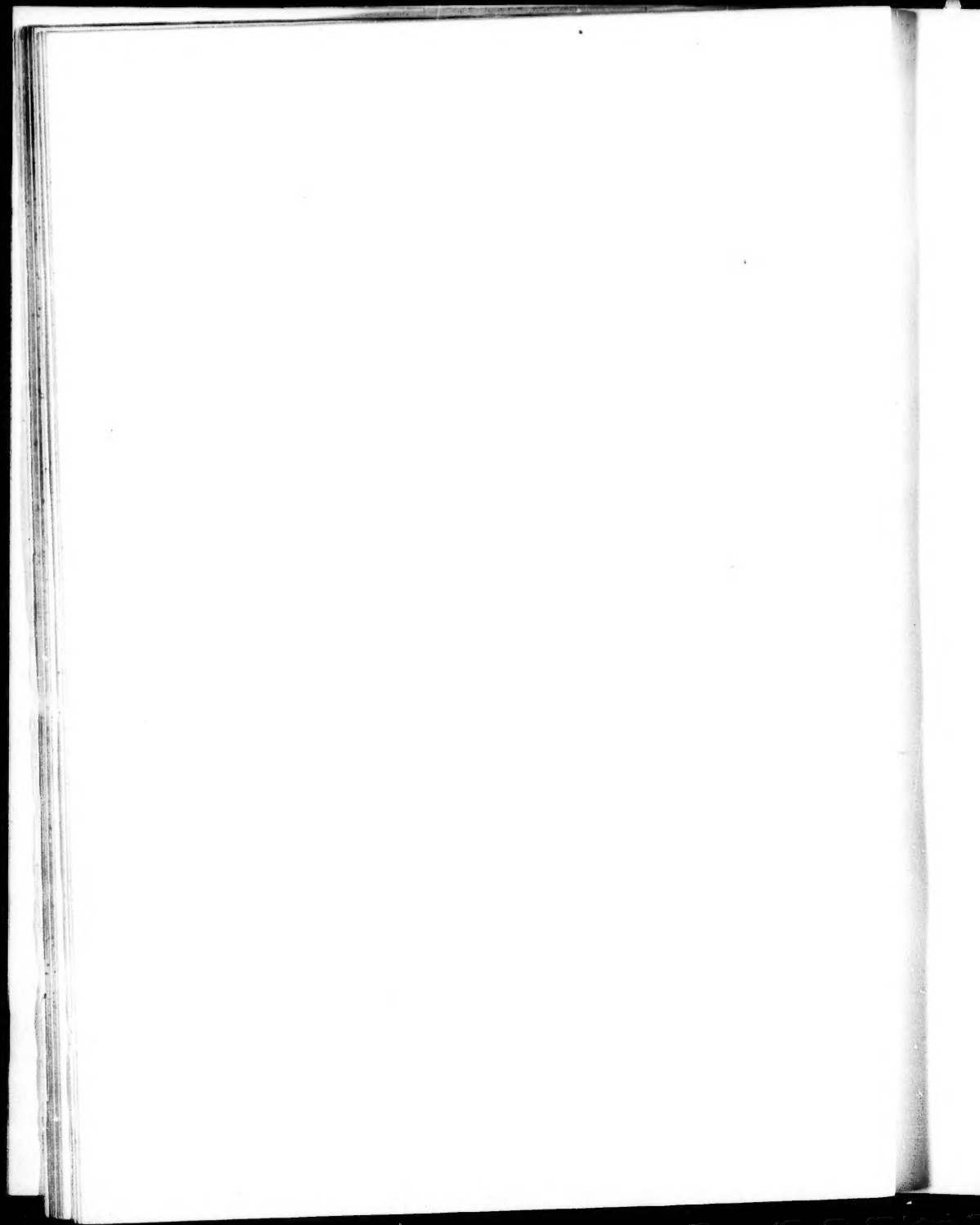
DEAR SIR: The records of the tidal observations made under the direction of Dr. Kane, in the second Grinnell Expedition to the Arctic Regions, were placed in my hands by his late lamented father, Judge Kane, in December, 1857.

Dr. Kane had selected Assistant Charles A. Schott, of the U. S. Coast Survey, for the reduction of a considerable portion of the observations made on that expedition; and I, therefore, placed them in Mr. Schott's possession for reduction, and recommend his paper for publication in the "Smithsonian Contributions to Knowledge." It is proper to state that the computations were at the expense of the Smithsonian Institution. This is the sixth and last paper of the series.

Very respectfully, yours,

A. D. BACHE,

*Superintendent U. S. Coast Survey.*



## RECORD AND REDUCTION OF THE TIDES.

THE observations and discussion of the tides at Van Rensselaer Harbor, the winter quarters of the *Advance* during 1853-54 and 1854-55, will form the last of the series of papers on the results of the expedition, prepared by me for publication.

Occasional tidal observations were made after passing Smith Straits, when, owing to the peculiar navigation through the narrow openings between the coast and the bay ice, the vessel was much exposed to the tidal action, frequently grounding at low water, and otherwise, by taking advantage of high tides, slowly advancing to her winter quarters.

The bay, near the head of which the *Advance* was laid up, and used as the winter quarters by Dr. Kane's party, is freely exposed to the north (true) and northwest; the indentation of the shore line is about five miles; some rocky islands are situated within the bay.

Shortly after the vessel entered the harbor a tide staff was arranged, and a series of tidal observations was commenced on September 11, 1853, and continued, with occasional interruptions (partly owing to defects in the pulley-gauge, afterwards rigged up, and partly owing to other unavoidable accidents) till the 24th of January, 1855, on which date the regular log book appears to have been discontinued.

The several series of observations during this period are of very unequal value, as will appear in the detailed examination and discussion of the results. The difficulties to be overcome in the attempt to secure a reliable set of observations were considerable, those of a physical nature being the greatest. The observations with the staff or sounding line are subject to irregularities from a slow movement of the vessel, which, though imbedded in ice during the greater part of the year, is yet not stationary; these observations may also be affected by the softness of the bottom; the observations by means of a pulley tide gauge may be defective, on account of a slow drift of the vessel and motion of the ice field, also in consequence of a lengthening or shortening of the rope, or it may be in consequence of slipping of the rope on the circumference of the wheel. The latter defect, or one similar in its nature, has been a source of much annoyance, requiring the application of corrections to the readings, in order to refer all observations to the same zero of the scale. There is another defect to which pulley-gauges are subject, namely, the gradual rise of the vessel, in consequence of the consumption of provisions and fuel. Notices of these defects will appear in the subsequent discussion.

The pulley-gauge is described by Dr. Kane, in volume I of the *Narrative*, p. 117, as follows: "Our tide register was on board the vessel, a simple pulley-gauge,



arranged with a wheel and index, and dependent on her rise and fall for its rotation."<sup>1</sup>

In order to ascertain the nature of the tides, as well as the degree of accuracy of the different observations, the readings were roughly plotted for a first examination; the following series were found suitable for discussion:—

**SERIES I.** *From October 10th, 1853, to December 28th, 1853.*—This series, with the exception of three days, is complete; the observations in the latter part of December appear to be of less reliable character. The observations between September 11 and October 4, 1853, are too fragmentary to be used. The pulley-gauge observations between October 4 and October 9 seem to have been only experimental. The hourly readings are superseded by half-hourly readings on November 8, and continue half hourly, day and night, to the end of the series. After November 28, corrective soundings were taken at noon each day. In order to make use of these soundings, the mean depth of the water at the anchorage was deduced from them as follows:—

|                 | Mean reading                            |    |
|-----------------|-----------------------------------------|----|
| December, 1853. | 43.8 feet, from 31 soundings (at noon). |    |
| January, 1854.  | 44.9                                    | 21 |
| February, "     | 44.3                                    | 17 |
| March, "        | 43.3                                    | 19 |
| April, "        | 41.8                                    | 20 |
| May, "          | 43.5                                    | 9  |

The individual soundings will appear in the record following.

Mean depth of water at anchorage, in winter, 1853-54, 43.6 feet, as obtained from 117 soundings. The monthly mean values for the tidal level accord well, and show that no lateral change took place in the position of the brig (or else that the bottom was level). It will be seen that for Series I the reading 7.0 was adopted to express the mean level, the zero of the scale was, therefore, at an elevation of 36.6 feet from the bottom. The readings of the pulley gauge are expressed in feet,<sup>2</sup> as I have been informed by Mr. Sonntag.

**SERIES II.** *From January 28th, 1854, to April 7th, 1854.*—The double half-hourly readings of the pulley-gauge are continued. The series is complete with the exception of ten days, which had to be omitted. The register broke January 22d; observations commenced January 24th, but were not sufficiently regular for use

<sup>1</sup> The following note is appended: One end of the cord represented a fixed point, by being anchored to the bottom; the free end, with an attached weight, rose and fell with the brig, and recorded its motion on the grooved circumference of a wheel. This method was liable to objections, but it was corrected by daily soundings. The movements of our vessel partook of those of the floe in which she was imbedded, and were unaccompanied by any lateral deviation.

<sup>2</sup> The following is an extract from Mr. Sonntag's letter to me, dated New York, March 23, 1860: "The circumference of the wheel (of the pulley-gauge) was divided into feet and tenths of a foot, and the records by the sounding line are also expressed in feet and decimals. The records of the wheel are very uncertain, as often the rope slid over the wheel without turning it, owing to the ice which surrounded the axis."

until January 28th. The corrective soundings at noon are continued, with occasional omissions, throughout this series. After April 7th there is a break in the observations, those between the 14th and 20th appear to be irregular.

**SERIES III. From April 20th, 1854, to August 3d, 1854.**—The double half-hourly readings of the pulley-gauge continue to May 5th, after which date single half-hourly readings are recorded. The corrective soundings cease on the 12th of May. Interruptions occur between May 4th and May 7th, also on July 8th, also between July 15th and 18th, and between July 20th and the 28th. On the 8th of August the brig was released from her ice cradle, and rose two and a half feet; occasional warpings of the brig after this date render the observations worthless. On the 23d of August the brig was in but seven feet of water, and grounded.

**SERIES IV. From September 7th, 1854, to October 22d, 1854.**—The hourly observations assume again a more regular appearance on the 7th of September; they were taken with the sounding line, and are expressed in fathoms and feet (as stated in a note, August 12th). The following note is of October 21st, 1854: "The tide register as yet not rigged, observations very faulty by sounding line." The irregularities increase after this date; on the 15th of November following, the tide register was arranged, and observations (hourly) commenced on the 17th; the slipping of the rope, however, was of so frequent occurrence and of so great an extent, that it was considered better to take no further notice of these observations; the record continues to January 24th, 1855, when the strength of the party no longer permitted due attention to the tidal phenomena.

It was apparent that before any closer insight into the nature of these tides could be obtained, they must first be reduced to the same zero or mean level of the sea. To effect this in a manner apparently best suiting the case, and otherwise unobjectionable, two curved lines were traced on the diagrams, the upper one enveloping the highest high water of each day, the other enveloping the lowest low water of each day; in tracing these lines some allowance was made, when necessary, for disturbing causes, so as to obtain tolerably smooth curves; cases of abrupt changes were, of course, treated accordingly. A line, equidistant from these curves, was assumed as representing the mean level, and when straightened out was adopted as axis of the mean level of the sea. The corrections to refer each observation to this adopted mean level; or, in other words, the corrections required to refer each observation to the same zero of the scale, so as to make them comparable with each other, were taken from the projection, and are given in the column headed "reduction," in the following record.

This method of treatment excludes necessarily in Series I, II, and III, any discussion of the variation in the mean level of the sea, the oscillations of which have been found small at other places. As an illustration of this, the tides at Singapore might be referred to; the Rev. W. Whewell (7th series of researches on the tides, *Phil. Trans. of the Roy. Soc.*, Part I, 1837), finds for these tides that, if a line is drawn representing the mean height (midway between high and low water each day) it is very nearly constant, though the successive low waters often differ by six



The note of February 3d, 1854, is very instructive in regard to the effect of the tides on the ice floe, viz: "The enormous elevation of the land ice by the tides has raised a barrier of broken tables seventy-two feet wide and twenty feet high between the brig and islands. This action has caused a recession of the main floe; our vessel has changed her position twenty feet within the last two spring tides, and the hawser connected with Butler Island parted with the strain." The cutwater of the brig was then 280 feet from the margin of the ice. (Note of February 4th.)

The mean of all the soundings taken during the fourth series is very nearly fifteen feet, hence the constant index error, to refer the observations to the level previously adopted, is eight feet, which correction was applied, converting at the same time the record of fathoms into feet.

The following tidal record extends, therefore, over about nine and a half lunations between October 10, 1853, and October 22, 1854, during which interval the time and height of nearly five hundred high and as many low waters were secured.

*Record of the Observations of the Tides at Van Rensselaer Harbor, North Greenland, in 1853, 1854, and 1855.*

POSITION OF THE WINTER QUARTERS,

Latitude  $78^{\circ} 37'$  north, and longitude  $70^{\circ} 53'$ , or  $4^{\circ} 43'.5$  west of Greenwich.<sup>1</sup>

The first column for each day is copied from the original log-book, the second column contains the reduction to the adopted zero of scale found graphically as explained, and the third column contains the observations referred to the same mean level.

<sup>1</sup> See my discussion of the astronomical observations of the expedition in vol. XII of the Smithsonian Contributions to Knowledge, 1860.

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## October, 1853.

| Mean<br>solar<br>hour. | 10th.<br>to<br>level. | Ref.<br>obs. | 11th.<br>to<br>level. | Ref.<br>obs. | 12th.<br>to<br>level. | Ref.<br>obs. | 13th.<br>to<br>level. | Ref.<br>obs. | 14th.<br>to<br>level. | Ref.<br>obs. | 15th.<br>to<br>level. | Ref.<br>obs. | 16th.<br>to<br>level. | Ref.<br>obs. |
|------------------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|
| 1                      | ---                   | ---          | 5.4                   | -1.0         | 4.4                   | 5.0          | -1.0                  | 4.0          | 7.5                   | -1.3         | 6.2                   | 7.0          | -1.5                  | 5.5          |
| 2                      | 6.6                   | -1.0         | 5.6                   | 5.4          | 4.4                   | 5.0          | ---                   | 4.0          | 6.4                   | ---          | 5.1                   | 5.4          | ---                   | 3.9          |
| 3                      | 7.6                   | ---          | 6.6                   | 5.5          | ---                   | 4.5          | 5.2                   | ---          | 4.2                   | 5.0          | ---                   | 3.7          | 4.4                   | ---          |
| 4                      | 8.1                   | ---          | 7.1                   | 6.0          | ---                   | 5.0          | 6.0                   | ---          | 5.0                   | 5.5          | ---                   | 4.2          | 4.2                   | ---          |
| 5                      | 8.7                   | ---          | 7.7                   | 6.9          | ---                   | 5.9          | 7.0                   | ---          | 6.0                   | 7.0          | ---                   | 6.6          | 4.4                   | -1.6         |
| 6                      | 8.7                   | ---          | 7.7                   | 7.3          | ---                   | 6.3          | 8.5                   | ---          | 7.5                   | 8.3          | ---                   | 7.0          | 5.5                   | ---          |
| 7                      | 8.7                   | ---          | 7.7                   | 7.7          | ---                   | 6.7          | 8.9                   | ---          | 7.9                   | 8.7          | -1.4                  | 7.3          | 7.5                   | ---          |
| 8                      | 9.0                   | ---          | 8.0                   | 7.7          | ---                   | 6.7          | 8.9                   | ---          | 7.9                   | 8.4          | ---                   | 8.0          | 9.6                   | ---          |
| 9                      | 6.4                   | ---          | 5.4                   | 7.6          | ---                   | 6.6          | ---                   | ---          | 10.5                  | ---          | 9.1                   | 11.2         | ---                   | 9.6          |
| 10                     | 5.9                   | ---          | 4.9                   | 6.6          | ---                   | 5.6          | 7.8                   | -1.1         | 6.7                   | 10.5         | ---                   | 9.1          | 11.4                  | ---          |
| 11                     | 5.7                   | ---          | 4.7                   | 6.1          | ---                   | 5.1          | 6.7                   | ---          | 5.6                   | 10.3         | ---                   | 8.9          | 11.3                  | ---          |
| Noon                   | 5.8                   | ---          | 4.8                   | 5.8          | ---                   | 4.8          | 5.6                   | ---          | 4.5                   | 9.9          | ---                   | 8.5          | 11.0                  | -1.7         |
| 1                      | 6.7                   | ---          | 5.7                   | 5.8          | ---                   | 4.8          | 5.3                   | ---          | 4.2                   | 7.6          | ---                   | 6.2          | 9.4                   | ---          |
| 2                      | 7.3                   | ---          | 6.3                   | 5.8          | ---                   | 4.8          | 5.3                   | ---          | 4.2                   | 6.7          | ---                   | 5.3          | 7.4                   | ---          |
| 3                      | 8.9                   | ---          | 7.9                   | 6.3          | ---                   | 5.3          | 5.3                   | ---          | 4.2                   | 5.6          | -1.5                  | 4.1          | 6.6                   | ---          |
| 4                      | 9.3                   | ---          | 8.3                   | 7.7          | ---                   | 6.7          | 5.3                   | ---          | 4.2                   | 4.6          | ---                   | 3.1          | 4.4                   | ---          |
| 5                      | 10.2                  | ---          | 9.2                   | 9.0          | ---                   | 8.0          | 6.4                   | -1.2         | 5.2                   | 6.5          | ---                   | 5.0          | 4.6                   | ---          |
| 6                      | 10.2                  | ---          | 9.2                   | 10.1         | ---                   | 9.1          | 7.8                   | ---          | 6.0                   | 9.0          | ---                   | 7.5          | 5.9                   | ---          |
| 7                      | 10.2                  | ---          | 9.2                   | 10.5         | ---                   | 9.5          | 9.9                   | ---          | 8.7                   | 10.5         | ---                   | 9.0          | 9.2                   | ---          |
| 8                      | 9.9                   | ---          | 8.9                   | 10.5         | ---                   | 9.5          | 11.0                  | ---          | 9.8                   | 11.6         | ---                   | 10.1         | 12.0                  | -1.8         |
| 9                      | 8.8                   | ---          | 7.8                   | 9.8          | ---                   | 8.8          | 11.3                  | -1.3         | 10.0                  | 12.4         | ---                   | 10.9         | 12.4                  | ---          |
| 10                     | 7.5                   | ---          | 6.5                   | 9.0          | ---                   | 8.0          | 11.3                  | ---          | 10.0                  | 12.4         | ---                   | 10.9         | 13.1                  | ---          |
| 11                     | 6.3                   | ---          | 5.3                   | 7.2          | ---                   | 6.2          | 9.7                   | ---          | 8.4                   | 12.4         | ---                   | 10.9         | 13.1                  | ---          |
| Midn.                  | 5.7                   | ---          | 4.7                   | 5.6          | ---                   | 4.6          | 8.3                   | ---          | 7.0                   | 10.4         | ---                   | 8.9          | 13.0                  | -1.0         |

## October, 1853.

| Mean<br>solar<br>hour. | 18th.<br>to<br>level. | Ref.<br>obs. | 19th.<br>to<br>level. | Ref.<br>obs. | 20th.<br>to<br>level. | Ref.<br>obs. | 21st.<br>to<br>level. | Ref.<br>obs. | 22d.<br>to<br>level. | Ref.<br>obs. | 23d.<br>to<br>level. | Ref.<br>obs. |
|------------------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|-----------------------|--------------|----------------------|--------------|----------------------|--------------|
| 1                      | 11.5                  | -2.7         | 8.8                   | 13.6         | -2.2                  | 11.4         | 13.8                  | -2.3         | 11.5                 | 11.6         | -1.7                 | 9.9          |
| 2                      | 8.9                   | ---          | 6.2                   | 12.0         | ---                   | 9.8          | 12.6                  | ---          | 10.3                 | ---          | ---                  | 10.2         |
| 3                      | 6.8                   | ---          | 4.1                   | 8.9          | ---                   | 6.7          | 10.5                  | ---          | 8.2                  | 10.8         | -1.6                 | 9.2          |
| 4                      | 5.5                   | ---          | 2.8                   | 6.6          | ---                   | 4.4          | 8.0                   | ---          | 5.7                  | 9.6          | -1.5                 | 8.1          |
| 5                      | 4.4                   | -2.6         | 1.8                   | 4.5          | ---                   | 2.3          | 7.9                   | -2.2         | 5.7                  | 6.7          | -1.4                 | 5.3          |
| 6                      | 6.4                   | ---          | 1.8                   | 3.8          | ---                   | 1.6          | 7.9                   | ---          | 5.7                  | 4.6          | ---                  | 3.2          |
| 7                      | 6.5                   | ---          | 3.9                   | 3.8          | ---                   | 1.6          | 7.9                   | ---          | 5.7                  | 4.1          | -1.3                 | 2.8          |
| 8                      | 8.7                   | ---          | 6.1                   | 4.7          | ---                   | 2.5          | 8.9                   | ---          | 6.7                  | 4.1          | -1.2                 | 2.9          |
| 9                      | 11.8                  | -2.5         | 9.3                   | 5.3          | ---                   | 3.1          | 8.7                   | ---          | 6.5                  | 6.7          | ---                  | 5.5          |
| 10                     | ---                   | ---          | ---                   | 11.0         | ---                   | 8.8          | 8.7                   | ---          | 1.6                  | 8.5          | -1.1                 | 7.4          |
| 11                     | ---                   | ---          | ---                   | 13.6         | ---                   | 11.4         | 12.9                  | ---          | 10.7                 | 10.8         | ---                  | 9.7          |
| Noon                   | ---                   | ---          | ---                   | 14.4         | ---                   | 12.2         | 13.6                  | ---          | 11.4                 | 14.7         | -1.0                 | 10.7         |
| 1                      | ---                   | ---          | ---                   | 14.6         | ---                   | 12.4         | 14.0                  | -2.1         | 11.9                 | 11.9         | ---                  | 10.9         |
| 2                      | 14.8                  | ---          | 12.3                  | 12.6         | ---                   | 10.4         | 14.0                  | ---          | 11.9                 | 11.9         | -0.9                 | 11.0         |
| 3                      | 10.6                  | -2.4         | 8.2                   | 10.4         | ---                   | 8.2          | ---                   | ---          | 11.9                 | -0.8         | 11.1                 | 9.5          |
| 4                      | 8.6                   | ---          | 6.2                   | 9.6          | -2.3                  | 7.3          | ---                   | ---          | 11.8                 | ---          | 11.0                 | 9.2          |
| 5                      | 6.6                   | ---          | 4.2                   | 6.6          | ---                   | 4.3          | 7.7                   | ---          | 5.8                  | 9.0          | -0.7                 | 8.3          |
| 6                      | 4.4                   | ---          | 2.0                   | 5.2          | ---                   | 2.5          | 6.2                   | ---          | 4.1                  | 7.5          | ---                  | 6.8          |
| 7                      | 4.4                   | -2.3         | 2.1                   | 4.2          | ---                   | 1.9          | 5.5                   | ---          | 3.4                  | 5.5          | -0.6                 | 4.9          |
| 8                      | 5.5                   | ---          | 3.2                   | 4.8          | ---                   | 2.5          | 5.2                   | -2.0         | 3.2                  | 5.0          | ---                  | 4.4          |
| 9                      | 8.3                   | ---          | 6.0                   | 6.8          | ---                   | 4.5          | 4.7                   | ---          | 2.7                  | 5.0          | -0.5                 | 4.5          |
| 10                     | 10.4                  | ---          | 8.1                   | 9.4          | ---                   | 7.1          | 6.8                   | -1.9         | 4.9                  | 5.0          | ---                  | 4.5          |
| 11                     | 12.6                  | ---          | 10.3                  | 11.6         | ---                   | 9.3          | 9.8                   | ---          | 7.0                  | 5.0          | -0.4                 | 4.6          |
| Midn.                  | 13.7                  | -2.2         | 11.5                  | 13.4         | ---                   | 11.1         | 11.0                  | -1.8         | 6.2                  | 5.0          | -0.3                 | 4.7          |

Regular observations commence October 10, 2 A. M.

Oct. 15. Tide rope found broken at 10 A. M., and the lead lost through the ice hole.

Oct. 17. Tides irregular, index changed 12 units; hence most of the observations on this day had to be omitted.

Oct. 29. The observation for 10 A. M. is incorrect, on account of obstruction by the day.

Oct. 21. Flood [rise] commenced at 8 P. M.

Oct. 23. Slack water [stand] at 8 o'clock, flood commences.

# RECORD AND REDUCTION OF THE TIDES.

7

SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.  
Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## October, 1853.

| Mean solar hour. | 24th. | Red. to level. | Ref. obs. | 25th. | Red. to level. | Ref. obs. | 26th. | Red. to level. | Ref. obs. | 27th. | Red. to level. | Ref. obs. | 28th. | Red. to level. | Ref. obs. | 29th. | Red. to level. | Ref. obs. |
|------------------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|
| 1                | 6.5   | +0.7           | 7.2       | 5.5   | -0.1           | 5.4       | 5.0   | +0.3           | 5.3       | 4.0   | +0.8           | 4.8       | 4.5   | +1.1           | 5.6       | 5.1   | +0.9           | 6.0       |
| 2                | 7.0   | "              | 7.1       | 5.8   | "              | 5.7       | 5.5   | "              | 5.8       | 4.0   | "              | 4.8       | 3.5   | "              | 4.6       | 4.4   | "              | 5.3       |
| 3                | 8.0   | "              | 8.7       | 6.5   | -0.2           | 6.3       | 5.5   | +0.4           | 5.9       | 4.5   | "              | 5.3       | 3.4   | "              | 4.5       | 2.8   | "              | 3.7       |
| 4                | 8.0   | +0.6           | 8.6       | 7.2   | "              | 7.0       | 5.8   | "              | 6.2       | 5.0   | +0.9           | 5.9       | 4.3   | "              | 5.4       | 2.5   | "              | 3.4       |
| 5                | 7.5   | "              | 7.9       | 7.3   | "              | 7.1       | 5.8   | "              | 6.2       | 6.0   | "              | 6.9       | 5.3   | "              | 6.4       | 3.0   | "              | 3.9       |
| 6                | 6.5   | "              | 7.1       | 7.0   | -0.3           | 6.7       | 6.2   | +0.5           | 6.7       | 6.8   | "              | 7.7       | 5.6   | "              | 6.7       | 5.5   | "              | 6.4       |
| 7                | 5.4   | "              | 6.0       | 6.4   | "              | 6.1       | 6.5   | "              | 7.0       | 7.1   | +1.0           | 8.1       | 7.3   | "              | 8.4       | 7.0   | "              | 7.9       |
| 8                | 4.0   | +0.5           | 4.5       | 5.6   | "              | 5.3       | 6.5   | "              | 7.0       | 7.1   | "              | 8.1       | 8.2   | "              | 9.3       | 7.8   | "              | 8.7       |
| 9                | 5.0   | "              | 5.5       | 5.6   | -0.4           | 5.2       | 6.1   | "              | 6.6       | 7.1   | "              | 8.1       | ---   | "              | ---       | 9.8   | "              | 10.7      |
| 10               | 5.0   | "              | 5.5       | 5.6   | "              | 5.2       | 5.6   | "              | 6.1       | 6.0   | "              | 7.0       | ---   | "              | ---       | 9.8   | "              | 10.7      |
| 11               | 5.0   | "              | 5.5       | 5.6   | "              | 5.2       | 5.5   | +0.6           | 6.1       | 5.6   | "              | 6.6       | ---   | "              | ---       | 9.6   | "              | 10.5      |
| Noon             | 5.0   | +0.4           | 5.4       | 5.6   | "              | 5.2       | 5.5   | "              | 6.1       | 4.5   | "              | 5.5       | ---   | "              | ---       | 9.3   | "              | 10.2      |
| 1                | 7.7   | "              | 8.1       | 7.3   | -0.3           | 7.0       | 5.5   | "              | 6.1       | 4.5   | "              | 5.5       | 4.8   | "              | 5.9       | 6.8   | "              | 7.7       |
| 2                | ---   | "              | ---       | 6.3   | "              | 6.0       | 5.5   | "              | 6.1       | 5.0   | "              | 6.0       | 4.3   | "              | 5.4       | 4.8   | "              | 5.7       |
| 3                | ---   | "              | ---       | 6.8   | -0.2           | 6.6       | 6.0   | "              | 6.6       | 5.3   | "              | 6.3       | 4.0   | "              | 5.1       | 4.0   | "              | 4.9       |
| 4                | ---   | "              | ---       | 7.5   | "              | 7.3       | 6.5   | "              | 7.1       | 6.3   | "              | 7.3       | 4.0   | "              | 5.1       | 4.0   | "              | 4.9       |
| 5                | 9.5   | +0.2           | 9.7       | 7.3   | -0.1           | 7.2       | 7.5   | +0.7           | 8.2       | 7.7   | "              | 8.7       | 6.0   | "              | 7.1       | 4.0   | "              | 4.9       |
| 6                | 9.5   | "              | 9.7       | 7.6   | "              | 7.5       | 8.0   | "              | 8.7       | 7.3   | +1.1           | 8.4       | 7.1   | "              | 8.2       | 5.5   | "              | 6.4       |
| 7                | 8.1   | +0.1           | 8.2       | 8.3   | "              | 8.2       | 8.2   | "              | 8.9       | 8.6   | "              | 9.7       | 8.0   | +1.0           | 9.0       | 6.7   | "              | 7.6       |
| 8                | 7.0   | "              | 7.1       | 8.5   | 0.0            | 8.5       | 8.5   | "              | 9.2       | 8.7   | "              | 9.8       | 9.4   | "              | 10.4      | 9.0   | "              | 9.9       |
| 9                | 6.0   | 0.0            | 6.0       | 7.1   | "              | 7.1       | 8.5   | "              | 9.2       | 8.7   | "              | 9.8       | 9.8   | "              | 10.8      | 9.3   | "              | 10.4      |
| 10               | 5.8   | "              | 5.8       | 6.1   | +0.1           | 6.2       | 7.1   | "              | 7.8       | 7.1   | +1.2           | 8.3       | 8.0   | "              | 10.8      | 10.5  | "              | 11.4      |
| 11               | 5.5   | -0.1           | 5.4       | 5.4   | "              | 5.5       | 6.1   | +0.8           | 6.9       | 6.3   | "              | 7.5       | 9.0   | +0.5           | 9.9       | 10.5  | "              | 11.4      |
| Midn't           | 5.5   | "              | 5.4       | 5.0   | +0.2           | 5.2       | 4.8   | "              | 5.6       | 5.9   | "              | 7.1       | 7.3   | "              | 8.2       | 8.5   | "              | 9.4       |

## October, 1853.

## November, 1853.

| Mean solar hour. | 30th. | Red. to level. | Ref. obs. | 31st. | Red. to level. | Ref. obs. | 1st. | Red. to level. | Ref. obs. | 2d.  | Red. to level. | Ref. obs. | 3d.  | Red. to level. | Ref. obs. | 4th. | Red. to level. | Ref. obs. |
|------------------|-------|----------------|-----------|-------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|
| 1                | 4.5   | +0.9           | 5.4       | 5.4   | +1.5           | 6.9       | 6.8  | +1.7           | 8.5       | 9.1  | +1.4           | 10.5      | 13.5 | -1.7           | 11.8      | 13.0 | -1.4           | 11.6      |
| 2                | 3.5   | "              | 4.4       | 3.8   | "              | 5.3       | 4.0  | "              | 5.7       | 8.8  | +1.3           | 10.1      | 12.0 | "              | 10.3      | 12.5 | "              | 11.1      |
| 3                | 3.0   | "              | 2.9       | 3.0   | +1.6           | 4.6       | 2.5  | "              | 4.2       | 7.1  | +1.2           | 8.3       | 9.0  | "              | 7.3       | 11.2 | "              | 9.8       |
| 4                | 2.0   | "              | 2.9       | 0.0   | "              | 1.6       | 1.0  | "              | 2.7       | 4.7  | +1.0           | 5.7       | 6.7  | -1.6           | 5.1       | 9.8  | "              | 8.4       |
| 5                | 3.2   | "              | 4.1       | 1.0   | "              | 2.6       | 1.0  | "              | 2.7       | 4.5  | +0.7           | 2.2       | 3.7  | "              | 2.1       | 6.0  | "              | 4.6       |
| 6                | 4.2   | "              | 5.1       | 1.2   | "              | 2.8       | 2.2  | "              | 3.9       | 0.5  | +0.5           | 1.0       | 1.8  | "              | 0.2       | 4.4  | "              | 3.0       |
| 7                | 6.2   | +1.0           | 7.2       | 3.1   | +1.7           | 4.8       | 3.2  | "              | 4.9       | 0.7  | +0.2           | 0.9       | 1.5  | -1.5           | 0.0       | 2.0  | "              | 0.6       |
| 8                | 8.5   | "              | 9.5       | 6.5   | "              | 8.2       | 7.0  | "              | 8.7       | 3.0  | 0.0            | 3.0       | 2.4  | "              | 0.9       | 1.7  | "              | 0.3       |
| 9                | 10.1  | +1.1           | 11.2      | 8.5   | "              | 10.2      | 9.5  | +1.6           | 11.1      | 7.2  | -0.2           | 7.0       | 3.4  | "              | 1.9       | 3.7  | "              | 2.3       |
| 10               | 10.4  | "              | 11.5      | 9.3   | "              | 11.0      | 10.5 | "              | 12.1      | 9.8  | -0.5           | 9.3       | 4.2  | "              | 2.7       | 7.3  | "              | 5.9       |
| 11               | 10.4  | "              | 11.5      | 10.3  | "              | 12.0      | 10.7 | "              | 12.3      | 10.9 | -0.7           | 10.2      | 6.0  | "              | 4.5       | 10.5 | "              | 9.1       |
| Noon             | 10.4  | +1.2           | 11.6      | 10.0  | "              | 11.7      | 10.7 | "              | 12.3      | 15.3 | -1.0           | 14.3      | 6.7  | "              | 5.2       | 12.6 | "              | 11.2      |
| 1                | 8.2   | "              | 9.4       | 7.5   | "              | 9.2       | 10.2 | "              | 11.8      | 15.2 | -1.2           | 14.0      | 15.7 | "              | 14.2      | ---  | "              | ---       |
| 2                | 5.5   | "              | 6.7       | 5.2   | "              | 6.9       | 9.2  | "              | 10.8      | 13.6 | -1.5           | 12.1      | 13.2 | "              | 13.7      | ---  | "              | ---       |
| 3                | 3.7   | "              | 4.9       | 3.7   | "              | 5.4       | 8.1  | "              | 9.7       | 10.5 | -1.6           | 8.9       | 12.5 | "              | 11.0      | ---  | "              | ---       |
| 4                | 3.4   | "              | 4.6       | 0.1   | "              | 1.8       | 4.5  | +1.5           | 6.9       | 6.8  | -1.7           | 5.1       | 10.1 | "              | 8.3       | 11.5 | "              | 10.6      |
| 5                | 2.6   | +1.3           | 3.9       | 0.2   | "              | 1.9       | 3.0  | "              | 4.5       | 3.8  | "              | 2.1       | 6.5  | "              | 5.0       | 9.0  | "              | 7.6       |
| 6                | 3.4   | "              | 4.7       | 1.2   | "              | 2.9       | 2.3  | "              | 3.8       | 2.0  | "              | 0.1       | 4.5  | "              | 3.0       | 5.5  | "              | 4.1       |
| 7                | 5.1   | "              | 6.4       | 3.0   | "              | 4.7       | 2.1  | "              | 3.6       | 1.8  | "              | 0.1       | 3.5  | "              | 2.0       | 3.2  | "              | 1.8       |
| 8                | 6.5   | "              | 8.1       | 5.2   | "              | 6.9       | 4.0  | "              | 5.5       | 3.2  | "              | 1.5       | 3.5  | "              | 2.0       | 3.0  | "              | 1.6       |
| 9                | 9.8   | +1.4           | 10.9      | 8.1   | "              | 9.8       | 9.0  | "              | 10.5      | 3.3  | "              | 1.6       | 4.5  | "              | 3.0       | 3.1  | "              | 1.7       |
| 10               | 10.3  | "              | 11.7      | 9.5   | "              | 11.2      | 10.1 | "              | 11.6      | 3.3  | "              | 1.6       | 7.3  | "              | 5.8       | 5.0  | "              | 3.6       |
| 11               | 10.3  | "              | 11.7      | 9.5   | "              | 11.2      | 10.1 | "              | 11.6      | 3.3  | "              | 1.6       | 9.3  | "              | 7.8       | 7.5  | "              | 6.1       |
| Midn't           | 9.0   | +1.5           | 10.5      | 10.5  | "              | 12.2      | 10.1 | "              | 11.6      | 3.3  | "              | 1.6       | 12.0 | "              | 10.5      | 9.8  | "              | 8.4       |

Oct. 29. Slack water [stand] of ebb at 4:30 A. M.  
Oct. 31. Slack water [stand] of ebb at 5 A. M.  
Nov. 2 to Nov. 6. Between these dates there are occasionally half-hourly readings, but unless they occur near high or low water they are omitted in the above.

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## November, 1853.

| Mean<br>solar<br>hour. | 5th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 6th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 7th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 8th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 9th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 10th.<br>Red.<br>to<br>level. | Ref.<br>obs. |      |      |      |      |      |      |     |
|------------------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|-------------------------------|--------------|------|------|------|------|------|------|-----|
| 1                      | 11.5                         | -1.4         | 10.1                         | 9.0          | -1.0                         | 8.0          | 6.6                          | -0.6         | 6.0                          | 4.3          | -0.5                          | 3.8          | 3.8  | +0.2 | 4.0  | 4.5  | -0.2 | 4.3  |     |
| 2                      | 11.0                         | "            | 9.6                          | 9.8          | "                            | 8.8          | 7.9                          | "            | 7.3                          | 5.6          | "                             | 5.1          | 4.2  | "    | 4.4  | 4.3  | "    | 4.1  |     |
| 3                      | 10.0                         | "            | 8.6                          | 10.0         | "                            | 9.0          | 8.8                          | "            | 8.2                          | 7.1          | "                             | 6.6          | 5.0  | "    | 5.2  | 4.5  | -0.3 | 4.2  |     |
| 4                      | 9.2                          | -1.3         | 7.9                          | 10.0         | -0.9                         | 9.1          | 8.8                          | "            | 8.2                          | 7.9          | "                             | 7.4          | 6.0  | "    | 6.2  | 4.1  | "    | 3.8  |     |
| 5                      | 8.7                          | "            | 4.4                          | 7.7          | "                            | 6.8          | 8.6                          | "            | 8.2                          | 7.9          | -0.4                          | 7.5          | 7.5  | "    | 5.8  | 5.5  | "    | 5.5  |     |
| 6                      | 8.5                          | "            | 2.2                          | 5.5          | "                            | 4.6          | 7.8                          | -0.5         | 7.3                          | 7.8          | "                             | 7.4          | 7.9  | "    | 8.1  | 8.5  | "    | 8.2  |     |
| 7                      | 2.3                          | "            | 1.0                          | 4.5          | "                            | 3.6          | 6.5                          | "            | 6.0                          | 7.3          | -0.3                          | 7.0          | 8.0  | +0.1 | 8.1  | 9.5  | "    | 9.6  |     |
| 8                      | 2.0                          | "            | 0.7                          | 3.6          | -0.8                         | 2.8          | 5.4                          | "            | 4.9                          | 6.3          | "                             | 6.0          | 8.0  | "    | 8.1  | 10.2 | -0.4 | 9.8  |     |
| 9                      | 2.4                          | "            | 1.1                          | 3.1          | "                            | 2.3          | 4.0                          | "            | 3.5                          | 5.5          | "                             | 5.2          | 6.9  | "    | 7.0  | 10.2 | "    | 9.8  |     |
| 10                     | 2.6                          | "            | 1.3                          | 3.2          | "                            | 2.4          | 4.0                          | "            | 3.5                          | 5.5          | "                             | 5.0          | 6.0  | "    | 10.1 | 9.7  | "    | 9.7  |     |
| 11                     | 2.7                          | -1.2         | 1.5                          | 4.3          | "                            | 3.5          | 3.7                          | "            | 3.2                          | 5.3          | "                             | 5.0          | 6.0  | "    | 6.1  | 9.8  | "    | 9.4  |     |
| 12                     | 6.7                          | "            | 5.5                          | 5.7          | -0.7                         | 5.0          | 4.4                          | "            | 3.9                          | 5.5          | "                             | 5.2          | 4.8  | "    | 4.9  | 9.0  | "    | 8.6  |     |
| Noon                   | 11.1                         | "            | 9.9                          | 8.3          | "                            | 7.6          | 6.8                          | "            | 6.3                          | 5.1          | -0.2                          | 5.1          | 4.9  | 4.6  | 0.0  | 4.6  | 7.5  | -0.5 | 7.0 |
| 1                      | 13.1                         | "            | 11.9                         | ---          | "                            | ---          | 8.1                          | "            | 7.6                          | 5.6          | "                             | 5.4          | 4.4  | "    | 4.4  | 6.5  | "    | 6.0  |     |
| 2                      | 13.6                         | "            | 12.4                         | ---          | "                            | ---          | 9.5                          | "            | 9.0                          | 7.1          | "                             | 6.9          | 4.5  | "    | 4.5  | 6.3  | "    | 5.8  |     |
| 3                      | 14.2                         | "            | 13.0                         | ---          | "                            | ---          | 10.6                         | "            | 10.1                         | 8.3          | "                             | 8.1          | 5.5  | "    | 5.5  | 6.0  | "    | 5.5  |     |
| 4                      | 14.1                         | -1.1         | 13.0                         | ---          | "                            | ---          | 10.6                         | "            | 10.1                         | 8.3          | "                             | 8.1          | 5.5  | "    | 5.5  | 6.0  | -0.6 | 5.9  |     |
| 5                      | 13.0                         | "            | 11.9                         | ---          | "                            | ---          | 10.9                         | "            | 10.4                         | 9.5          | "                             | 9.3          | 7.1  | "    | 7.1  | 7.0  | "    | 6.4  |     |
| 6                      | 12.3                         | "            | 11.2                         | ---          | "                            | ---          | 11.2                         | "            | 10.7                         | 9.5          | "                             | 9.3          | 7.1  | "    | 7.1  | 7.0  | "    | 6.4  |     |
| 7                      | 10.8                         | "            | 9.7                          | 11.0         | -0.6                         | 10.9         | 11.2                         | "            | 10.7                         | 10.1         | -0.1                          | 10.0         | 9.2  | -0.1 | 9.1  | 7.9  | "    | 7.3  |     |
| 8                      | 8.2                          | "            | 7.1                          | 9.1          | "                            | 8.5          | 10.2                         | "            | 9.7                          | 10.5         | "                             | 10.4         | 9.6  | "    | 10.0 | 9.5  | "    | 8.9  |     |
| 9                      | 5.1                          | "            | 4.0                          | 7.5          | "                            | 6.9          | 8.5                          | "            | 8.0                          | 10.5         | "                             | 10.4         | 11.1 | "    | 11.0 | 10.9 | "    | 10.3 |     |
| 10                     | 3.3                          | "            | 2.2                          | 5.4          | "                            | 4.8          | 7.5                          | "            | 7.0                          | 10.0         | 0.0                           | 10.0         | 11.0 | "    | 10.9 | 11.0 | "    | 10.4 |     |
| 11                     | 2.9                          | "            | 1.8                          | ---          | "                            | ---          | ---                          | "            | ---                          | 10.5         | "                             | 10.4         | 11.1 | "    | 10.9 | 11.0 | "    | 10.4 |     |
| 12                     | 3.0                          | "            | 1.9                          | 4.2          | "                            | 3.6          | 5.6                          | "            | 5.1                          | 8.1          | "                             | 8.1          | 8.9  | "    | 8.8  | 11.0 | "    | 10.4 |     |
| 1                      | 8.5                          | "            | 2.4                          | 4.0          | "                            | 3.4          | ---                          | "            | ---                          | ---          | "                             | ---          | ---  | "    | ---  | ---  | "    | ---  |     |
| 2                      | 4.1                          | -1.0         | 3.1                          | 3.2          | "                            | 2.6          | 4.4                          | "            | 3.9                          | 7.0          | +0.1                          | 7.1          | 7.0  | "    | 6.9  | 11.3 | -0.7 | 10.6 |     |
| 3                      | 6.0                          | "            | 5.0                          | 4.0          | "                            | 3.4          | 4.1                          | "            | 3.6                          | 4.9          | "                             | 5.0          | 4.7  | -0.2 | 4.5  | 9.5  | "    | 10.2 |     |
| 4                      | 7.3                          | "            | 6.3                          | 4.9          | "                            | 4.3          | 4.0                          | "            | 3.5                          | 4.0          | +0.2                          | 4.2          | 4.5  | "    | 4.3  | 8.5  | "    | 7.8  |     |
| Mean't                 | 7.3                          | "            | 6.3                          | 4.9          | "                            | 4.3          | 4.0                          | "            | 3.5                          | 4.0          | +0.2                          | 4.2          | 4.5  | "    | 4.3  | 8.5  | "    | 7.8  |     |

Nov. 8. From this date the observations are half-hourly; in the above record, however, only those half-hourly readings were inserted, which occur near a high or low water.

## RECORD AND REDUCTION OF THE TIDES.

9

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## November, 1853.

| Mean<br>solar<br>hour. | 11th. | Red.<br>to<br>level. | Ref.<br>obs. | 12th. | Red.<br>to<br>level. | Ref.<br>obs. | 13th. | Red.<br>to<br>level. | Ref.<br>obs. | 14th. | Red.<br>to<br>level. | Ref.<br>obs. | 15th. | Red.<br>to<br>level. | Ref.<br>obs. | 16th. | Red.<br>to<br>level. | Ref.<br>obs. |      |
|------------------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|------|
| 1                      | 6.1   | -0.7                 | 5.4          | 6.0   | -0.9                 | 5.1          | 8.8   | -1.6                 | 7.2          | 11.5  | -4.1                 | 7.4          | 13.0  | -5.2                 | 7.8          | 15.1  | -5.5                 | 11.3         |      |
| 2                      | 3.6   | -0.8                 | 2.8          | 5.5   | "                    | 4.6          | 6.7   | "                    | 5.1          | 9.1   | -4.2                 | 4.9          | 10.0  | "                    | 4.8          | 14.7  | -5.6                 | 9.1          |      |
| 3                      | 3.5   | "                    | 2.7          | 4.0   | -1.0                 | 3.0          | 4.9   | -1.7                 | 3.2          | 7.5   | -4.3                 | 3.2          | 8.0   | "                    | 2.8          | 13.0  | "                    | 7.4          |      |
| 4                      | 4.1   | "                    | 3.3          | 3.8   | "                    | 2.8          | 4.4   | -1.8                 | 2.6          | 6.5   | -4.4                 | 2.1          | 6.6   | "                    | 1.4          | 10.5  | "                    | 4.9          |      |
| 5                      | 5.0   | "                    | 4.2          | 4.6   | "                    | 3.6          | 4.5   | -1.9                 | 2.6          | 6.5   | "                    | 2.1          | 5.9   | "                    | 0.8          | 6.1   | -5.7                 | 6.4          |      |
| 6                      | 5.6   | "                    | 4.8          | 7.1   | "                    | 6.1          | 5.5   | "                    | 3.6          | 7.0   | -4.5                 | 2.5          | 6.2   | "                    | 1.0          | 6.3   | "                    | 6.5          |      |
| 7                      | 8.0   | "                    | 7.2          | 8.6   | "                    | 7.6          | 7.5   | -2.0                 | 5.5          | 9.0   | "                    | 4.5          | 8.0   | "                    | 2.8          | 7.3   | -5.9                 | 1.4          |      |
| 8                      | 9.5   | "                    | 8.7          | 10.5  | "                    | 9.5          | 10.2  | -2.1                 | 8.1          | 12.4  | -4.6                 | 7.8          | 10.5  | "                    | 5.3          | 10.0  | -6.0                 | 4.0          |      |
| 9                      | 10.3  | "                    | 9.5          | 11.2  | "                    | 10.6         | 12.7  | "                    | 10.6         | 15.5  | "                    | 10.9         | 12.9  | "                    | 7.7          | 12.7  | "                    | 6.7          |      |
| 10                     | 10.0  | "                    | 9.2          | 12.2  | "                    | 11.2         | 13.7  | -2.3                 | 10.8         | 17.6  | -4.7                 | 12.3         | 16.0  | "                    | 10.8         | 16.4  | -6.1                 | 10.3         |      |
| 11                     | 9.5   | "                    | 8.7          | 11.7  | -1.1                 | 10.6         | 13.5  | "                    | 11.2         | 17.3  | -4.9                 | 12.4         | 18.5  | "                    | 13.3         | 17.9  | "                    | 11.8         |      |
| Noon                   | 7.5   | "                    | 6.7          | 9.0   | "                    | 7.9          | 12.1  | -2.4                 | 9.7          | 16.4  | -5.0                 | 11.4         | 18.3  | -5.3                 | 13.0         | 19.9  | -6.3                 | 13.6         |      |
| 1                      | 6.0   | "                    | 5.2          | 8.0   | "                    | 6.9          | 11.1  | -2.5                 | 8.6          | 14.1  | "                    | 9.1          | 17.6  | "                    | 12.3         | 18.7  | -6.4                 | 12.3         |      |
| 2                      | 5.3   | "                    | 4.5          | 6.3   | "                    | 5.2          | 9.1   | -2.6                 | 6.5          | 12.0  | "                    | 7.0          | 15.5  | "                    | 10.2         | 17.9  | "                    | 11.5         |      |
| 3                      | 5.0   | "                    | 4.2          | 4.9   | "                    | 3.8          | 7.8   | -2.7                 | 5.1          | 9.3   | -5.1                 | 4.2          | 12.0  | "                    | 6.7          | 15.0  | "                    | 8.6          |      |
| 4                      | 5.5   | "                    | 4.7          | 5.0   | "                    | 3.9          | 6.3   | -2.8                 | 3.5          | 8.5   | "                    | 3.4          | 10.3  | "                    | 5.0          | 12.6  | -6.5                 | 6.1          |      |
| 5                      | 6.6   | "                    | 5.8          | 5.5   | -1.2                 | 4.3          | 6.3   | -2.9                 | 3.4          | 8.0   | "                    | 2.9          | 8.9   | "                    | 3.6          | 10.6  | "                    | 4.1          |      |
| 6                      | 8.0   | "                    | 7.2          | 6.4   | "                    | 5.2          | 5.5   | -3.0                 | 2.5          | 8.5   | -5.2                 | 3.3          | 8.9   | -5.4                 | 3.5          | 10.0  | "                    | 3.3          |      |
| 7                      | 10.0  | "                    | 9.2          | 7.7   | "                    | 6.5          | 8.7   | -3.2                 | 5.5          | 9.6   | "                    | 4.4          | 9.2   | "                    | 3.8          | 10.0  | -6.8                 | 3.2          |      |
| 8                      | 11.4  | -0.9                 | 10.5         | 10.4  | -1.3                 | 9.1          | 11.0  | -3.3                 | 7.7          | 11.4  | "                    | 6.2          | 10.7  | "                    | 5.3          | 11.5  | -7.0                 | 4.5          |      |
| 9                      | 12.7  | "                    | 11.8         | 11.8  | "                    | 10.5         | 13.7  | -3.4                 | 10.3         | 13.1  | "                    | 7.9          | 13.7  | "                    | 8.3          | 14.6  | "                    | 7.0          |      |
| 10                     | 12.1  | "                    | 11.2         | 12.7  | -1.4                 | 11.3         | 14.4  | -3.6                 | 10.8         | 14.7  | "                    | 9.5          | 16.6  | "                    | 11.2         | 16.0  | "                    | 9.0          |      |
| 11                     | 11.4  | "                    | 10.5         | 11.9  | "                    | 10.5         | 14.8  | -3.8                 | 11.0         | 14.6  | "                    | 9.4          | 17.8  | "                    | 12.4         | 17.5  | -7.1                 | 10.4         |      |
| Midn't                 | 9.2   | "                    | 8.3          | 10.6  | -1.5                 | 9.1          | 13.6  | -4.0                 | 9.6          | 14.1  | "                    | 9.3          | 18.5  | -5.5                 | 13.0         | 18.0  | "                    | 10.9         |      |
|                        |       |                      |              |       |                      |              |       |                      |              |       |                      |              |       |                      |              | 13.0  | 17.9                 | "            | 10.8 |



**SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.**

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

**November, 1853.**

| Mean solar hour. | 17th. | Red. to level. | Ref. obs. | 18th. | Red. to level. | Ref. obs. | 19th. | Red. to level. | Ref. obs. | 20th. | Red. to level. | Ref. obs. | 21st. | Red. to level. | Ref. obs. | 22d. | Red. to level. | Ref. obs. |
|------------------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|------|----------------|-----------|
| 1                | 17.8  | -7.2           | 10.6      | 1.4   | +12.3          | 13.7      | 16.5  | -6.7           | 9.8       | 16.5  | -8.2           | 8.3       |       |                |           |      |                |           |
|                  | 17.0  | "              | 9.8       | 1.0   | "              | 13.3      | 16.5  | "              | 9.8       | 17.0  | "              | 8.8       | 17.3  | -9.0           | 7.7       | 3.5  | +3.2           | 6.7       |
| 2                | 16.0  | -7.3           | 8.7       | 20.0  | -7.6           | 12.7      | 16.5  | "              | 9.8       | 17.4  | -8.3           | 9.1       | 17.5  | "              | 7.9       | 3.9  | "              | 7.1       |
|                  | 16.0  | "              | 8.7       | 20.0  | "              | 7.5       | 12.5  | 16.5           | "         | 9.3   | 16.6           | "         | 8.5   | 17.6           | "         | 8.0  | 4.3            | +3.1      |
| 3                | 14.9  | -7.4           | 7.5       | 18.0  | "              | 10.5      | 15.1  | -6.8           | 8.3       | 16.0  | "              | 7.7       | 17.6  | -9.7           | 7.9       | 4.5  | +2.9           | 7.4       |
|                  | 14.9  | "              | 7.5       | 18.0  | "              | 10.5      | 15.1  | -6.8           | 8.3       | 16.0  | "              | 7.7       | 17.6  | -9.7           | 7.9       | 4.5  | "              | 7.4       |
| 4                | 12.0  | -7.5           | 4.5       | 16.5  | "              | 9.0       | 13.8  | "              | 7.0       | 14.5  | -8.4           | 6.1       | 16.5  | "              | 6.8       | 4.0  | +2.8           | 6.8       |
|                  | 12.0  | "              | 4.5       | 16.5  | "              | 9.0       | 13.8  | "              | 7.0       | 14.5  | -8.4           | 6.1       | 16.5  | "              | 6.8       | 4.0  | "              | 6.8       |
| 5                | 10.4  | "              | 2.9       | 14.3  | -7.4           | 6.9       | 11.4  | -6.9           | 4.5       | 12.7  | "              | 4.3       | 13.6  | "              | 3.9       | 3.2  | +2.5           | 5.8       |
|                  | 10.4  | "              | 2.9       | 14.3  | -7.4           | 6.9       | 11.4  | -6.9           | 4.5       | 12.7  | "              | 4.3       | 13.6  | "              | 3.9       | 3.2  | "              | 5.8       |
| 6                | 9.8   | -7.6           | 2.2       | 13.5  | "              | 6.1       | 10.2  | "              | 3.3       | 12.0  | -8.5           | 3.5       | 13.4  | -9.8           | 3.6       | 3.5  | +2.6           | 5.6       |
|                  | 9.8   | "              | 2.2       | 13.5  | "              | 6.1       | 10.2  | "              | 3.3       | 12.0  | -8.5           | 3.5       | 13.4  | -9.8           | 3.6       | 3.5  | "              | 5.6       |
| 7                | 9.0   | -7.7           | 1.3       | 7.2   | -7.3           | -0.1      | 9.0   | -7.1           | 1.9       | 11.6  | "              | 3.1       | 13.0  | "              | 3.2       | 3.3  | +2.4           | 5.7       |
|                  | 9.0   | "              | 1.3       | 7.2   | -7.3           | -0.1      | 9.0   | -7.1           | 1.9       | 11.6  | "              | 3.1       | 13.0  | "              | 3.2       | 3.3  | "              | 5.7       |
| 8                | 11.0  | "              | 2.3       | 7.5   | "              | 0.2       | 10.2  | -7.2           | 2.8       | 11.2  | "              | 2.7       | 13.0  | "              | 3.2       | 3.0  | "              | 5.4       |
|                  | 11.0  | "              | 2.3       | 7.5   | "              | 0.2       | 10.2  | -7.2           | 2.8       | 11.2  | "              | 2.7       | 13.0  | "              | 3.2       | 3.0  | +2.3           | 5.3       |
| 9                | 13.5  | "              | 5.8       | 11.9  | -7.2           | 4.7       | 12.0  | "              | 4.7       | 12.4  | -8.7           | 3.7       | 13.1  | "              | 3.3       | 2.9  | "              | 5.2       |
|                  | 13.5  | "              | 5.8       | 11.9  | -7.2           | 4.7       | 12.0  | "              | 4.7       | 12.4  | -8.7           | 3.7       | 13.1  | "              | 3.3       | 2.9  | +2.2           | 5.2       |
| 10               | 16.1  | -7.8           | 8.3       | 14.5  | "              | 7.3       | 14.9  | -7.4           | 7.5       | 14.5  | -8.8           | 5.7       | 16.7  | "              | 6.9       | 3.5  | "              | 5.7       |
|                  | 16.1  | -7.8           | 8.3       | 14.5  | "              | 7.3       | 14.9  | -7.4           | 7.5       | 14.5  | -8.8           | 5.7       | 16.7  | "              | 6.9       | 3.5  | "              | 5.7       |
| 11               | 19.3  | "              | 11.5      | 17.0  | -7.1           | 9.9       | 17.3  | "              | 9.9       | 17.5  | -8.9           | 8.6       | 19.1  | "              | 9.3       | 4.3  | "              | 6.5       |
|                  | 19.3  | "              | 11.5      | 17.0  | -7.1           | 9.9       | 17.3  | "              | 9.9       | 17.5  | -8.9           | 8.6       | 19.1  | "              | 9.3       | 4.3  | "              | 6.5       |
| Noon             | 20.0  | "              | 12.2      |       |                |           |       |                |           |       |                |           |       |                |           |      |                |           |
|                  | 20.8  | "              | 13.0      | 18.5  | -7.0           | 11.5      | 19.2  | -7.5           | 11.7      | 19.5  | -9.0           | 10.5      | 19.5  | -9.9           | 9.6       | 5.6  | +2.1           | 7.7       |
| 1                | 20.6  | "              | 12.8      | 19.0  | -6.9           | 12.1      | 20.0  | "              | 12.5      | 20.5  | -9.1           | 11.4      | 20.0  | "              | 10.1      | 7.2  | +2.0           | 9.2       |
|                  | 20.6  | "              | 12.8      | 19.0  | -6.9           | 12.1      | 20.0  | "              | 12.5      | 20.5  | -9.1           | 11.4      | 20.0  | "              | 10.1      | 7.2  | "              | 9.2       |
| 2                | 19.0  | -7.9           | 11.1      | 18.5  | -6.8           | 11.7      | 20.0  | -7.6           | 12.4      | 20.6  | "              | 11.5      | 1.6   | +9.6           | 10.6      | 8.0  | +1.8           | 9.8       |
|                  | 19.0  | "              | 11.1      | 18.5  | -6.8           | 11.7      | 20.0  | -7.6           | 12.4      | 20.6  | "              | 11.5      | 1.6   | +9.6           | 10.6      | 8.0  | "              | 9.8       |
| 3                | 17.0  | "              | 9.1       | 16.3  | "              | 9.5       | 19.0  | "              | 12.0      | 20.5  | -9.2           | 11.3      | 5.2   | +4.9           | 10.1      | 8.4  | +1.6           | 10.0      |
|                  | 17.0  | "              | 9.1       | 16.3  | "              | 9.5       | 19.0  | "              | 12.0      | 20.5  | -9.2           | 11.3      | 5.2   | +4.9           | 10.1      | 8.4  | "              | 10.0      |
| 4                | 16.0  | "              | 8.1       | 14.4  | "              | 7.6       | 17.4  | -7.7           | 9.7       | 18.9  | -9.3           | 9.6       | 5.0   | +4.8           | 9.8       | 8.5  | +1.4           | 9.9       |
|                  | 16.0  | "              | 8.1       | 14.4  | "              | 7.6       | 17.4  | -7.7           | 9.7       | 18.9  | -9.3           | 9.6       | 5.0   | +4.8           | 9.8       | 8.5  | "              | 9.9       |
| 5                | 15.0  | "              | 7.1       | 12.5  | "              | 6.6       | 15.5  | -7.8           | 8.7       | 17.0  | "              | 8.6       | 5.0   | +4.8           | 9.8       | 8.5  | +1.4           | 9.9       |
|                  | 15.0  | "              | 7.1       | 12.5  | "              | 6.6       | 15.5  | -7.8           | 8.7       | 17.0  | "              | 8.6       | 5.0   | +4.8           | 9.8       | 8.5  | "              | 9.9       |
| 6                | 14.0  | "              | 6.1       | 10.6  | "              | 5.6       | 13.6  | -7.9           | 7.7       | 15.5  | "              | 7.7       | 3.9   | +4.6           | 8.5       | 8.0  | "              | 9.8       |
|                  | 14.0  | "              | 6.1       | 10.6  | "              | 5.6       | 13.6  | -7.9           | 7.7       | 15.5  | "              | 7.7       | 3.9   | +4.6           | 8.5       | 8.0  | "              | 9.8       |
| 7                | 13.0  | "              | 5.1       | 8.7   | "              | 4.6       | 11.7  | -8.0           | 6.7       | 14.0  | "              | 6.7       | 3.3   | "              | 7.0       | "    | "              | 9.7       |
|                  | 13.0  | "              | 5.1       | 8.7   | "              | 4.6       | 11.7  | -8.0           | 6.7       | 14.0  | "              | 6.7       | 3.3   | "              | 7.0       | "    | "              | 9.7       |
| 8                | 12.0  | "              | 4.1       | 6.8   | "              | 3.6       | 9.8   | -8.1           | 5.7       | 12.0  | "              | 5.7       | 2.7   | "              | 6.0       | "    | "              | 9.6       |
|                  | 12.0  | "              | 4.1       | 6.8   | "              | 3.6       | 9.8   | -8.1           | 5.7       | 12.0  | "              | 5.7       | 2.7   | "              | 6.0       | "    | "              | 9.6       |
| 9                | 11.0  | "              | 3.1       | 4.9   | "              | 2.6       | 7.9   | -8.2           | 4.7       | 10.0  | "              | 4.7       | 2.1   | "              | 5.0       | "    | "              | 9.5       |
|                  | 11.0  | "              | 3.1       | 4.9   | "              | 2.6       | 7.9   | -8.2           | 4.7       | 10.0  | "              | 4.7       | 2.1   | "              | 5.0       | "    | "              | 9.5       |
| 10               | 10.0  | "              | 2.1       | 3.0   | "              | 1.6       | 6.0   | -8.3           | 3.7       | 8.0   | "              | 3.7       | 1.5   | "              | 4.0       | "    | "              | 9.4       |
|                  | 10.0  | "              | 2.1       | 3.0   | "              | 1.6       | 6.0   | -8.3           | 3.7       | 8.0   | "              | 3.7       | 1.5   | "              | 4.0       | "    | "              | 9.4       |
| 11               | 9.0   | "              | 1.1       | 1.1   | "              | 0.6       | 4.1   | -8.4           | 2.7       | 6.0   | "              | 2.7       | 0.9   | "              | 3.0       | "    | "              | 9.3       |
|                  | 9.0   | "              | 1.1       | 1.1   | "              | 0.6       | 4.1   | -8.4           | 2.7       | 6.0   | "              | 2.7       | 0.9   | "              | 3.0       | "    | "              | 9.3       |
| 12               | 8.0   | "              | 0.1       | -0.8  | "              | -0.4      | 2.2   | -8.5           | 1.7       | 4.0   | "              | 1.7       | 0.3   | "              | 2.0       | "    | "              | 9.2       |
|                  | 8.0   | "              | 0.1       | -0.8  | "              | -0.4      | 2.2   | -8.5           | 1.7       | 4.0   | "              | 1.7       | 0.3   | "              | 2.0       | "    | "              | 9.2       |
| 13               | 7.0   | "              | -0.9      | -2.7  | "              | -1.2      | 0.3   | -8.6           | 0.7       | 2.0   | "              | 0.7       | 0.3   | "              | 1.0       | "    | "              | 9.1       |
|                  | 7.0   | "              | -0.9      | -2.7  | "              | -1.2      | 0.3   | -8.6           | 0.7       | 2.0   | "              | 0.7       | 0.3   | "              | 1.0       | "    | "              | 9.1       |
| 14               | 6.0   | "              | -1.9      | -4.5  | "              | -2.2      | -1.7  | -8.7           | -0.3      | 0.0   | "              | -0.3      | 0.0   | "              | 0.0       | "    | "              | 9.0       |
|                  | 6.0   | "              | -1.9      | -4.5  | "              | -2.2      | -1.7  | -8.7           | -0.3      | 0.0   | "              | -0.3      | 0.0   | "              | 0.0       | "    | "              | 9.0       |
| 15               | 5.0   | "              | -2.9      | -7.3  | "              | -3.2      | -4.5  | -8.8           | -1.3      | -1.0  | "              | -1.3      | -0.3  | "              | -1.0      | "    | "              | 8.9       |
|                  | 5.0   | "              | -2.9      | -7.3  | "              | -3.2      | -4.5  | -8.8           | -1.3      | -1.0  | "              | -1.3      | -0.3  | "              | -1.0      | "    | "              | 8.9       |
| 16               | 4.0   | "              | -3.9      | -10.1 | "              | -4.2      | -7.3  | -8.9           | -2.3      | -2.0  | "              | -2.3      | -1.3  | "              | -2.0      | "    | "              | 8.8       |
|                  | 4.0   | "              | -3.9      | -10.1 | "              | -4.2      | -7.3  | -8.9           | -2.3      | -2.0  | "              | -2.3      | -1.3  | "              | -2.0      | "    | "              | 8.8       |
| 17               | 3.0   | "              | -4.9      | -12.9 | "              | -5.2      | -10.1 | -9.0           | -3.3      | -3.0  | "              | -3.3      | -2.3  | "              | -3.0      | "    | "              | 8.7       |
|                  | 3.0   | "              | -4.9      | -12.9 | "              | -5.2      | -10.1 | -9.0           | -3.3      | -3.0  | "              | -3.3      | -2.3  | "              | -3.0      | "    | "              | 8.7       |
| 18               | 2.0   | "              | -5.9      | -15.7 | "              | -6.2      | -12.9 | -9.1           | -4.3      | -4.0  | "              | -4.3      | -3.3  | "              | -4.0      | "    | "              | 8.6       |
|                  | 2.0   | "              | -5.9      | -15.7 | "              | -6.2      | -12.9 | -9.1           | -4.3      | -4.0  | "              | -4.3      | -3.3  | "              | -4.0      | "    | "              | 8.6       |
| 19               | 1.0   | "              | -6.9      | -18.5 | "              | -7.2      | -15.7 | -9.2           | -5.3      | -5.0  | "              | -5.3      | -4.3  | "              | -5.0      | "    | "              | 8.5       |
|                  | 1.0   | "              | -6.9      | -18.5 | "              | -7.2      | -15.7 | -9.2           | -5.3      | -5.0  | "              | -5.3      | -4.3  | "              | -5.0      | "    | "              | 8.5       |
| 20               | 0.0   | "              | -7.9      | -21.3 | "              | -8.2      | -18.5 | -9.3           | -6.3      | -6.0  | "              | -6.3      | -5.3  | "              | -6.0      | "    | "              | 8.4       |
|                  | 0.0   | "              | -7.9      | -21.3 | "              | -8.2      | -18.5 | -9.3           | -6.3      | -6.0  | "              | -6.3      | -5.3  | "              | -6.0      | "    | "              | 8.4       |
| 21               | -1.0  | "              | -8.9      | -24.1 | "              | -9.2      | -21.3 | -9.4           | -7.3      | -7.0  | "              | -7.3      | -6.3  | "              | -7.0      | "    | "              | 8.3       |
|                  | -1.0  | "              | -8.9      | -24.1 | "              | -9.2      | -21.3 | -9.4           | -7.3      | -7.0  | "              | -7.3      | -6.3  | "              | -7.0      | "    | "              | 8.3       |
| 22               | -2.0  | "              | -9.9      | -26.9 | "              | -10.2     | -24.1 | -9.5           | -8.3      | -8.0  | "              | -8.3      | -7.3  | "              | -8.0      | "    | "              | 8.2       |
|                  | -2.0  | "              | -9.9      | -26.9 | "              | -10.2     | -24.1 | -9.5           | -8.3      | -8.0  | "              | -8.3      | -7.3  | "              | -8.0      | "    | "              | 8.2       |
| 23               | -3.0  | "              | -10.9     | -29.7 | "              | -11.2     | -26.9 | -9.6           | -9.3      | -9.0  | "              | -9.3      | -8.3  | "              | -9.0      | "    | "              | 8.1       |
|                  | -3.0  | "              | -10.9     | -29.7 | "              | -11.2     | -26.9 | -9.6           | -9.3      | -9.0  | "              | -9.3      | -8.3  | "              | -9.0      | "    | "              | 8.1       |
| 24               | -4.0  | "              | -11.9     | -32.5 | "              | -12.2     | -29.7 | -9.7           | -10.3     | -10.0 | "              | -10.3     | -9.3  | "              | -10.0     | "    | "              | 8.0       |
|                  | -4.0  | "              | -11.9     | -32.5 | "              | -12.2     | -29.7 | -9.7           | -10.3     | -10.0 | "              | -10.3     | -9.3  | "              | -10.0     | "    | "              | 8.0       |
| 25               | -5.0  | "              | -12.9     | -35.3 | "              | -13.2     | -32.5 | -9.8           | -11.3     | -11.0 | "              | -11.3     | -10.3 | "              | -11.0     | "    | "              | 7.9       |
|                  | -5.0  | "              | -12.9     | -35.3 | "              | -13.2     | -32.5 | -9.8           | -11.3     | -11.0 | "              | -11.3     | -10.3 | "              | -11.0     | "    | "              | 7.9       |
| 26               | -6.0  | "              | -13.9     | -38.1 | "              | -14.2     | -35.3 | -9.9           | -12.3     | -12.0 | "              | -12.3     | -11.3 | "              | -12.0     | "    | "              | 7.8       |
|                  | -6.0  | "              | -13.9     | -38.1 | "              | -14.2     | -35.3 | -9.9           | -12.3     | -12.0 | "              | -12.3     | -11.3 | "              | -12.0     | "    | "              | 7.8       |
| 27               | -7.0  | "              | -14.9     | -40.9 | "              | -15.2     | -38.1 | -10.0          | -13.3     | -13.0 | "              | -13.3     | -12.3 | "              | -13.0     | "    | "              | 7.7       |
|                  | -7.0  | "              | -14.9     | -40.9 | "              | -15.2     | -38.1 | -10.0          | -13.3     | -13.0 | "              | -13.3     | -12.3 | "              | -13.0     | "    | "              | 7.7       |
| 28               | -8.0  | "              | -15.9     | -43.7 | "              | -16.2     | -40.9 | -10.1          | -14.3     | -14.0 | "              | -14.3     | -13.3 | "              | -14.0     | "    | "              | 7.6       |
|                  | -8.0  | "              | -15.9     | -43.7 | "              | -16.2     | -40.9 | -10.1          | -14.3     | -14.0 | "              | -14.3     | -13.3 | "              | -14.0     | "    | "              | 7.6       |
| 29               | -9.0  | "              | -16.9     | -46.5 | "              | -17.2     | -43.7 | -10.2          | -15.3     | -15.0 | "              | -15.3     | -14.3 | "              | -15.0     | "    | "              | 7.5       |
|                  | -9.0  | "              | -16.9     | -46.5 | "              | -17.2     | -43.7 | -10.2          | -15.3     | -15.0 | "              | -15.3     | -14.3 | "              | -15.0     | "    | "              | 7.5       |
| 30               | -10.0 | "              | -17.9     | -49.3 | "              | -18.2     | -46.5 | -10.3          | -16.3     | -16.0 | "              | -16.3     | -15   |                |           |      |                |           |

# RECORD AND REDUCTION OF THE TIDES.

11

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### November, 1853.

| Mean solar hour. | 23d. | Red. to level. | Ref. obs. | 24th. | Red. to level. | Ref. obs. | 25th. | Red. to level. | Ref. obs. | 26th. | Red. to level. | Ref. obs. | 27th. | Red. to level. | Ref. obs. | 28th. | Red. to level. | Ref. obs. |     |
|------------------|------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-----|
| 1                | 4.7  | +0.4           | 5.1       | 6.7   | -3.0           | 3.7       | 10.0  | -6.3           | 3.7       | 14.8  | -10.3          | 4.5       | 14.7  | -10.4          | 4.3       | 17.5  | -12.0          | 5.5       |     |
| 2                | 5.0  | +0.2           | 5.8       | 7.8   | -3.3           | 4.5       | 10.4  | -6.4           | 4.0       | 14.6  | "              | 4.3       | 13.7  | "              | 3.3       | 15.3  | -12.1          | 3.2       |     |
| 3                | 6.2  | 0.0            | 6.2       | 9.1   | -3.5           | 5.6       | 11.2  | -6.6           | 4.6       | 15.2  | -10.5          | 4.7       | 13.1  | -10.3          | 2.8       | 14.7  | -12.2          | 2.5       |     |
| 4                | 7.0  | -0.2           | 6.8       | 10.0  | -3.6           | 6.4       | 12.5  | -6.7           | 5.8       | 15.5  | -10.6          | 4.9       | 13.2  | -10.4          | 2.8       | 14.6  | -12.3          | 2.2       |     |
| 5                | 7.0  | -0.3           | 6.7       | 10.5  | -3.7           | 6.8       | 13.0  | -6.9           | 6.7       | 16.5  | "              | 5.9       | 16.0  | "              | 5.6       | 15.6  | -12.4          | 3.2       |     |
| 6                | 7.5  | -0.5           | 7.0       | 11.1  | -3.8           | 7.3       | 15.6  | -7.0           | 8.0       | 18.0  | -10.7          | 7.3       | 17.3  | "              | 6.9       | 18.2  | -12.5          | 5.7       |     |
| 7                | 7.5  | -0.6           | 6.9       | 11.6  | -3.9           | 7.7       | 15.7  | -7.1           | 8.6       | 19.4  | "              | "         | 8.7   | 19.8           | -10.5     | 9.3   | 20.3           | -12.6     | 7.7 |
| 8                | 7.6  | -0.7           | 6.9       | 11.6  | -3.9           | 7.7       | 15.7  | -7.1           | 8.6       | 19.4  | "              | "         | 8.7   | 19.8           | -10.5     | 9.3   | 20.3           | -12.6     | 7.7 |
| 9                | 7.8  | -0.8           | 7.0       | 11.9  | -4.0           | 8.0       | 16.0  | -7.2           | 8.8       | "     | "              | "         | 9.2   | 20.9           | -10.6     | 10.3  | 22.6           | -12.7     | 9.9 |
| 10               | 7.9  | -0.9           | 7.0       | 12.5  | -4.0           | 8.5       | 15.6  | -7.3           | 8.3       | 20.0  | -10.8          | 9.2       | 20.9  | -10.6          | 10.3      | 22.6  | -12.7          | 9.9       |     |
| 11               | 7.8  | -0.9           | 6.9       | 11.6  | -4.1           | 7.5       | "     | -7.4           | 7.8       | 20.0  | "              | 9.4       | 21.2  | "              | 10.6      | 23.8  | "              | 11.1      |     |
| 12               | 7.7  | -1.0           | 6.7       | 11.0  | -4.2           | 6.8       | 15.2  | -7.4           | 7.8       | 20.0  | "              | 9.2       | 21.5  | -10.7          | 10.8      | 24.5  | -12.8          | 11.7      |     |
| 13               | 7.7  | "              | 6.7       | "     | "              | "         | "     | -7.4           | 7.8       | 20.0  | "              | 8.7       | 21.6  | "              | 10.0      | 24.7  | "              | 11.9      |     |
| 14               | 7.7  | -1.1           | 6.6       | 9.5   | -4.4           | 5.1       | 15.7  | -7.6           | 8.1       | 19.0  | -10.7          | 8.3       | 21.3  | -10.8          | 10.5      | 24.8  | "              | 12.0      |     |
| 15               | 7.7  | "              | 6.6       | "     | "              | "         | "     | -7.6           | 8.1       | 19.0  | -10.7          | 8.3       | 21.3  | -10.8          | 10.5      | 24.8  | "              | 11.5      |     |
| 16               | 8.0  | -1.2           | 6.8       | 9.0   | -4.5           | 4.5       | 16.0  | -7.8           | 8.2       | 17.8  | "              | 7.1       | 20.9  | -10.9          | 10.0      | 23.8  | -12.9          | 10.9      |     |
| 17               | 8.6  | -1.3           | 7.3       | 8.0   | -4.6           | 3.4       | 15.5  | -8.0           | 7.5       | 16.3  | "              | 5.6       | 19.2  | "              | 8.3       | 22.7  | "              | 9.8       |     |
| 18               | 9.6  | -1.5           | 8.1       | 9.9   | -4.7           | 5.2       | 15.4  | -8.2           | 7.2       | 15.7  | "              | 5.0       | 18.2  | -11.0          | 7.2       | 21.4  | -13.0          | 8.4       |     |
| 19               | 10.4 | -1.6           | 8.8       | 10.3  | -4.8           | 5.5       | 15.8  | -8.3           | 6.9       | 15.4  | "              | 4.7       | 17.1  | "              | 6.1       | 18.4  | "              | 5.4       |     |
| 20               | 11.4 | -1.8           | 9.6       | 11.4  | -4.9           | 6.5       | 16.0  | -8.6           | 7.4       | 15.1  | "              | 4.4       | 17.1  | "              | 6.1       | 18.4  | "              | 5.4       |     |
| 21               | 11.8 | -2.0           | 9.8       | 12.6  | -5.0           | 7.6       | 16.4  | -8.8           | 7.6       | 15.5  | -10.6          | 4.4       | 15.2  | -11.1          | 4.1       | 17.1  | "              | 4.1       |     |
| 22               | 12.0 | -2.1           | 9.9       | "     | "              | "         | "     | -8.6           | 7.6       | 15.5  | -10.6          | 4.4       | 14.9  | "              | 3.8       | 15.8  | "              | 2.8       |     |
| 23               | 12.0 | -2.2           | 9.8       | 13.5  | -5.1           | 8.4       | 18.1  | -9.0           | 9.1       | 17.0  | "              | 4.9       | 14.9  | -11.2          | 3.4       | 15.7  | "              | 2.7       |     |
| 24               | 12.0 | -2.3           | 9.7       | 13.9  | -5.2           | 8.7       | 19.1  | -9.1           | 10.0      | "     | "              | 16.9      | "     | 5.7            | 15.6      | "     | 2.6            |           |     |
| 25               | 12.2 | "              | 9.9       | 14.6  | -5.3           | 9.3       | 19.6  | -9.3           | 10.3      | 19.1  | "              | 6.4       | 17.5  | -11.3          | 6.2       | 15.9  | "              | 2.9       |     |
| 26               | 11.8 | -2.4           | 9.4       | 14.9  | -5.4           | 9.5       | 19.7  | -9.4           | 10.3      | "     | "              | 8.5       | 19.3  | -11.4          | 7.9       | 17.7  | "              | 4.7       |     |
| 27               | 11.4 | "              | 9.0       | 14.4  | -5.5           | 8.9       | 19.8  | -9.5           | 10.3      | 20.0  | "              | 9.4       | 20.9  | -11.5          | 9.4       | 20.0  | "              | 7.0       |     |
| 28               | 10.0 | -2.5           | 7.5       | 13.7  | -5.7           | 8.0       | 19.4  | -9.8           | 9.6       | 20.4  | -10.5          | 9.9       | 22.0  | "              | 10.5      | "     | "              | 9.0       |     |
| 29               | 9.0  | -2.6           | 6.4       | 12.8  | -5.9           | 6.9       | 18.5  | -9.9           | 8.6       | 20.4  | "              | 9.9       | 22.8  | "              | 11.2      | "     | "              | 9.0       |     |
| 30               | 8.2  | -2.7           | 5.5       | 12.5  | -6.0           | 6.5       | 18.0  | -10.0          | 8.0       | 19.8  | "              | 9.9       | 22.9  | -11.7          | 11.2      | 23.7  | "              | 10.7      |     |
| 31               | 7.7  | -2.8           | 4.9       | 11.5  | -6.1           | 5.4       | 16.0  | -10.1          | 5.9       | 17.7  | "              | 9.6       | 22.9  | "              | 11.2      | 23.9  | "              | 10.9      |     |
| 32               | 7.4  | -2.9           | 4.5       | "     | "              | "         | "     | -10.1          | 5.9       | 17.7  | "              | 9.3       | 22.6  | -11.8          | 10.8      | 23.9  | "              | 10.9      |     |
| 33               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 34               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 35               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 36               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 37               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 38               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 39               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 40               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 41               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 42               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 43               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 44               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 45               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 46               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 47               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 48               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 49               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 50               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 51               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 52               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 53               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 54               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 55               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 56               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 57               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 58               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 59               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 60               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 61               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 62               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 63               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 64               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 65               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 66               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 67               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 68               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 69               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 70               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 71               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 72               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 73               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 74               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 75               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  | -11.9          | 9.7       | 23.5  | "              | 11.0      |     |
| 76               | 7.2  | -3.0           | 4.2       | 10.9  | -6.2           | 4.7       | 15.0  | -10.3          | 4.7       | 16.2  | "              | 7.2       | 21.6  |                |           |       |                |           |     |

**SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.**

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| November, 1853. |               |                  |              |               |                  |              |              |                  |              | December, 1853. |                  |              |             |                  |              |              |                  |              |  |
|-----------------|---------------|------------------|--------------|---------------|------------------|--------------|--------------|------------------|--------------|-----------------|------------------|--------------|-------------|------------------|--------------|--------------|------------------|--------------|--|
| Mean<br>of hour | 20th.<br>obs. | Red.<br>to level | Ref.<br>obs. | 20th.<br>obs. | Red.<br>to level | Ref.<br>obs. | 1st.<br>obs. | Red.<br>to level | Ref.<br>obs. | 2d.<br>obs.     | Red.<br>to level | Ref.<br>obs. | 3d.<br>obs. | Red.<br>to level | Ref.<br>obs. | 4th.<br>obs. | Red.<br>to level | Ref.<br>obs. |  |
| 1               | 14.7          | -13.0            | 5.7          | 14.1          | -5.8             | 7.3          | 15.0         | -6.6             | 8.4          | 17.6            | "                | 8.9          | 19.3        | -9.9             | 9.4          | 18.6         | "                | 7.8          |  |
| 2               | 15.8          | -12.9            | 2.9          | 9.3           | "                | 3.5          | 12.4         | "                | 5.8          | 15.5            | -8.8             | 6.7          | 17.8        | "                | 7.9          | 19.2         | -10.9            | 8.3          |  |
| 3               | 14.7          | "                | 1.8          | 7.2           | "                | 1.4          | 9.2          | -6.7             | 2.5          | 12.1            | -8.9             | 3.2          | 16.0        | "                | 6.1          | 18.7         | -11.0            | 7.7          |  |
| 4               | 14.1          | "                | 1.2          | 7.0           | "                | 1.2          | "            | "                | "            | "               | "                | "            | "           | "                | "            | "            | "                | "            |  |
| 5               | 13.8          | -12.8            | 1.0          | 6.2           | "                | 0.4          | 8.2          | -6.8             | 1.4          | 10.1            | -9.0             | 1.1          | 14.1        | "                | 4.2          | 17.1         | "                | 6.1          |  |
| 6               | 13.5          | "                | 0.7          | 5.9           | "                | 0.1          | "            | "                | "            | "               | "                | "            | "           | "                | "            | "            | "                | "            |  |
| 7               | 13.6          | "                | 0.8          | 6.8           | "                | 1.0          | 6.0          | "                | -0.8         | 8.0             | -9.1             | -1.1         | 11.6        | "                | 1.7          | 14.0         | -11.1            | 2.9          |  |
| 8               | 14.2          | 12.7             | 1.5          | 8.2           | "                | 2.1          | 5.6          | "                | -1.2         | 7.3             | "                | -1.8         | "           | "                | "            | 12.5         | "                | 1.4          |  |
| 9               | 14.7          | "                | 2.0          | 9.6           | "                | 3.8          | 6.5          | -6.9             | -0.4         | 7.4             | -9.2             | -2.1         | 10.1        | "                | 0.2          | 11.4         | -11.2            | 0.2          |  |
| 10              | 16.8          | -12.6            | 4.2          | 11.7          | "                | 5.9          | 7.5          | -7.0             | 0.5          | 9.8             | -9.4             | 0.4          | 9.5         | "                | -0.4         | 11.5         | "                | 0.3          |  |
| 11              | 19.7          | -12.5            | 7.2          | 13.8          | "                | 8.0          | 11.0         | "                | 4.0          | 10.5            | -9.5             | 1.0          | 11.2        | "                | 0.1          | 12.0         | -11.3            | 0.7          |  |
| 12              | 21.5          | -12.4            | 11.1         | 17.7          | "                | 11.9         | 13.8         | -7.1             | 6.7          | 14.6            | -9.6             | 5.0          | 14.2        | "                | 4.3          | 13.8         | "                | 2.5          |  |
| 13              | 25.2          | -12.3            | 12.9         | 19.2          | "                | 13.4         | 18.1         | -7.2             | 10.9         | 17.8            | -9.7             | 8.1          | 16.0        | "                | 6.1          | 17.3         | -11.4            | 5.9          |  |
| 14              | 25.5          | -12.2            | 13.3         | 19.5          | "                | 13.7         | "            | "                | "            | "               | "                | "            | "           | "                | "            | "            | "                | "            |  |
| 15              | 25.5          | -12.1            | 13.4         | 19.5          | "                | 13.7         | 19.3         | -7.3             | 12.0         | 20.2            | -9.8             | 10.4         | 18.3        | "                | 8.4          | 19.8         | "                | 8.4          |  |
| 16              | 25.8          | -12.0            | 13.8         | 19.2          | "                | 13.4         | "            | "                | 12.7         | 22.4            | -9.9             | 12.5         | "           | "                | "            | "            | "                | "            |  |
| 17              | 18.2          | -5.8             | 12.4         | 18.3          | "                | 12.5         | 20.2         | -7.4             | 12.8         | 22.9            | -10.0            | 12.9         | 21.6        | -9.8             | 11.8         | 21.7         | -11.5            | 10.2         |  |
| 18              | 17.1          | "                | 11.3         | "             | "                | 20.0         | "            | "                | 12.6         | 23.3            | "                | 13.3         | "           | "                | "            | "            | "                | "            |  |
| 19              | 15.2          | "                | 9.4          | 16.3          | "                | 10.5         | 19.8         | -7.5             | 12.3         | 23.6            | "                | 13.6         | 22.5        | "                | 12.7         | 23.8         | "                | 12.3         |  |
| 20              | 11.7          | "                | 5.9          | 13.0          | -5.9             | 7.1          | 16.9         | -7.6             | 9.3          | 22.0            | "                | 13.1         | 22.6        | "                | 12.8         | 24.7         | "                | 13.2         |  |
| 21              | 8.7           | "                | 2.9          | 9.0           | "                | 3.1          | 13.7         | -7.7             | 6.0          | 19.8            | "                | 12.0         | 22.7        | -9.9             | 12.8         | 25.2         | "                | 13.7         |  |
| 22              | 8.2           | "                | 2.4          | "             | "                | "            | "            | "                | "            | "               | "                | 21.5         | "           | "                | 11.6         | 24.3         | "                | 12.8         |  |
| 23              | 7.0           | -5.8             | 1.2          | 8.1           | -6.0             | 2.1          | 10.1         | -7.8             | 2.3          | 16.2            | "                | 9.8          | 20.5        | 10.0             | 10.5         | 23.9         | "                | 12.4         |  |
| 24              | 7.2           | "                | 1.4          | 8.0           | "                | 2.0          | "            | "                | "            | "               | "                | 6.2          | 18.0        | 10.1             | 7.9          | 21.8         | "                | 10.3         |  |
| 25              | 7.4           | "                | 1.3          | 7.7           | "                | 1.5          | 8.5          | -7.9             | 0.6          | 12.9            | "                | 2.9          | 15.7        | "                | 5.6          | 19.8         | "                | 8.3          |  |
| 26              | 7.4           | "                | 1.6          | 7.7           | "                | 1.7          | 8.1          | "                | 0.2          | "               | "                | 0.3          | "           | "                | "            | "            | "                | "            |  |
| 27              | 7.8           | "                | 2.0          | 8.0           | -6.1             | 1.9          | 7.7          | -8.0             | -0.3         | 10.9            | "                | 0.9          | 14.5        | 10.2             | 4.3          | 16.7         | "                | 5.2          |  |
| 28              | 9.2           | "                | 3.4          | 9.2           | "                | 3.1          | 7.7          | "                | -0.3         | 10.3            | "                | 0.6          | "           | "                | "            | "            | "                | "            |  |
| 29              | 10.0          | "                | 4.2          | 10.2          | "                | 4.1          | 8.2          | -8.1             | 0.1          | 10.0            | "                | 0.0          | 11.9        | 10.3             | 1.6          | 14.5         | "                | 3.0          |  |
| 30              | 13.3          | "                | 7.5          | 11.9          | -6.2             | 5.7          | 11.1         | -8.2             | 2.9          | 10.6            | "                | 0.6          | 11.2        | "                | 0.3          | "            | "                | "            |  |
| 31              | 14.8          | "                | 9.0          | 14.4          | "                | 8.2          | 12.6         | -8.3             | 4.3          | 12.0            | "                | 0.9          | 10.4        | 10.4             | 0.0          | 13.6         | "                | 2.1          |  |
| 32              | 15.9          | "                | 10.1         | 16.2          | -6.3             | 9.9          | 15.3         | -8.4             | 6.9          | 14.9            | "                | 19.3         | "           | -0.1             | 13.3         | "            | "                | "            |  |
| 33              | 16.5          | "                | 10.7         | 16.6          | -6.4             | 10.2         | 17.3         | -8.5             | 8.8          | 17.0            | "                | 2.0          | 11.3        | 10.5             | 0.8          | 13.1         | "                | 1.6          |  |
| 34              | 16.3          | "                | 10.5         | 17.0          | "                | 10.6         | 17.9         | "                | 9.4          | 18.2            | "                | 13.3         | "           | "                | 1.8          | "            | "                | "            |  |
| 35              | 16.1          | "                | 10.3         | 17.3          | -6.5             | 10.8         | 18.1         | -8.6             | 9.5          | 18.9            | "                | 3.1          | 14.0        | "                | 2.5          | "            | "                | "            |  |
| 36              | 16.5          | "                | 10.7         | 16.6          | -6.4             | 10.2         | 17.3         | -8.5             | 8.8          | 17.0            | "                | 4.9          | 13.7        | 10.6             | 3.1          | 14.0         | "                | 2.5          |  |
| 37              | 16.3          | "                | 10.5         | 17.0          | "                | 10.6         | 17.9         | "                | 9.4          | 18.2            | "                | 7.0          | 15.0        | 10.7             | 4.9          | 16.0         | "                | 4.5          |  |
| 38              | 16.1          | "                | 10.3         | 17.3          | -6.5             | 10.8         | 18.1         | -8.6             | 9.5          | 18.9            | "                | 8.2          | "           | "                | "            | "            | "                | "            |  |
| 39              | 16.1          | "                | 10.3         | 17.3          | -6.5             | 10.8         | 18.1         | -8.6             | 9.5          | 18.9            | "                | 8.9          | 18.2        | 10.8             | 7.4          | 17.8         | -11.5            | 6.3          |  |

Nov. 29. Tide register corrected at noon. Sounding at noon 7 fath., 0 feet, 4 inches, register 18.2. It may be remarked that soundings are subject to uncertainty in case of any drift of the ice field in which the vessel was imbedded, and also in case the bottom be soft. Some allowance must be made for stretch of the line.

|                           | Fath. | Feet. | Inch. | Reg. |                                                                                                 |
|---------------------------|-------|-------|-------|------|-------------------------------------------------------------------------------------------------|
| Nov. 30. Sounding at noon | 7     | 2     | 3     | 18.2 | (This sounding was not used, apparently not reliable.)                                          |
| Dec. 1. " "               | 8     | 0     | 0     | 20.2 |                                                                                                 |
| " 2. " "                  | 7     | 5     | 6     | 22.7 | A mean correction was used for these days, as deduced from enveloping curves and the soundings. |
| " 3. " "                  | 8     | 0     | 0     | 22.0 |                                                                                                 |
| " 4. " "                  | 7     | 4     | 0     | 22.0 |                                                                                                 |

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## December, 1853.

| Mean solar hour. | 5th. to level. | Red. obs. | Ref. obs. | 6th. to level. | Red. obs. | Ref. obs. | 7th. to level. | Red. obs. | Ref. obs. | 8th. to level. | Red. obs. | Ref. obs. | 9th. to level. | Red. obs. | Ref. obs. | 10th. to level. | Red. obs. | Ref. obs. |
|------------------|----------------|-----------|-----------|----------------|-----------|-----------|----------------|-----------|-----------|----------------|-----------|-----------|----------------|-----------|-----------|-----------------|-----------|-----------|
| 1                | 19.7           | -11.6     | 8.1       | 20.1           | -16.3     | 4.8       | 4.7            | -2.7      | 2.0       | 2.3            | +1.4      | 3.7       | 1.8            | -0.1      | 1.7       | 7.5             | -1.8      | 5.7       |
| 2                | 20.2           | "         | 8.6       | 21.6           | -15.8     | 5.8       | 5.2            | -3.1      | 2.1       | 3.1            | +0.8      | 3.9       | 1.4            | -0.2      | 1.2       | 7.3             | "         | 5.5       |
| 3                | 20.5           | -11.7     | 8.8       | 22.1           | -16.1     | 6.0       | 7.0            | -3.5      | 4.4       | 4.7            | +0.5      | 5.2       | 2.7            | -0.3      | 2.4       | 7.5             | -2.0      | 5.5       |
| 4                | 20.8           | "         | 9.1       | 22.5           | -16.4     | 6.1       | 9.0            | -3.9      | 5.1       | 5.6            | -0.3      | 5.9       | 3.6            | "         | 3.3       | 8.2             | "         | 6.2       |
| 5                | 20.4           | -11.8     | 8.6       | 22.4           | -16.6     | 5.8       | 10.0           | -4.4      | 5.6       | 7.0            | 0.6       | 7.0       | 7.0            | -0.4      | 6.6       | 9.5             | -2.1      | 7.4       |
| 6                | 19.9           | "         | 8.1       | 22.4           | -16.6     | 5.8       | 11.0           | -5.0      | 6.0       | 8.0            | -0.7      | 7.3       | 9.1            | "         | 8.7       | 11.2            | -2.2      | 9.0       |
| 7                | 19.2           | -11.9     | 7.3       | 22.5           | -16.9     | 5.6       | 12.1           | -5.2      | 6.9       | 9.8            | -2.2      | 7.6       | 10.3           | -0.5      | 9.8       | 12.3            | "         | 10.1      |
| 8                | 17.9           | -12.0     | 5.9       | 22.1           | -17.3     | 4.8       | 11.9           | -5.4      | 6.5       | 9.9            | -3.0      | 6.9       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 9                | 17.1           | -12.1     | 5.0       | 21.2           | -17.6     | 3.6       | 12.5           | -5.7      | 6.8       | 11.3           | -4.5      | 6.8       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 10               | 14.7           | -12.2     | 2.5       | 21.3           | -17.9     | 3.4       | 12.5           | -5.7      | 6.8       | 11.3           | -4.5      | 6.8       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 11               | 14.3           | "         | 2.1       | 20.5           | -18.1     | 2.4       | 12.5           | -5.7      | 6.8       | 11.3           | -4.5      | 6.8       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 12               | 13.6           | -12.3     | 1.3       | 20.6           | -18.3     | 2.3       | 12.5           | -5.7      | 6.8       | 11.3           | -4.5      | 6.8       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 13               | 13.6           | "         | 1.3       | 20.7           | -18.4     | 2.3       | 12.5           | -5.7      | 6.8       | 11.3           | -4.5      | 6.8       | 11.3           | "         | 10.8      | 13.0            | -2.3      | 10.7      |
| 14               | 14.7           | -12.4     | 1.3       | 21.1           | -18.6     | 2.5       | 12.3           | -6.3      | 6.0       | 11.4           | -6.0      | 5.4       | 11.6           | "         | 11.0      | 13.3            | -2.4      | 10.9      |
| 15               | 14.4           | "         | 2.0       | 21.7           | -18.5     | 5.2       | 11.7           | -6.5      | 5.2       | 11.2           | -0.7      | 10.5      | 11.2           | "         | 10.5      | 13.5            | "         | 11.1      |
| 16               | 15.2           | -12.5     | 2.7       | 21.6           | -18.9     | 2.7       | 12.2           | -6.8      | 5.4       | 12.4           | -7.5      | 4.9       | 10.7           | "         | 10.0      | 13.3            | -2.5      | 10.8      |
| 17               | 17.8           | -12.6     | 5.2       | 22.7           | -19.3     | 3.4       | 11.2           | -7.3      | 3.9       | 13.2           | -9.0      | 4.2       | 9.7            | -0.8      | 8.9       | 11.8            | "         | 9.3       |
| 18               | 19.0           | -12.7     | 6.3       | 24.7           | -19.6     | 4.1       | 11.1           | -7.7      | 3.4       | 13.6           | -10.5     | 3.1       | 8.9            | -0.9      | 7.1       | 9.8             | -2.6      | 7.2       |
| 19               | 20.9           | -12.9     | 8.0       | 26.7           | -19.9     | 6.8       | 17.1           | -13.1     | 4.0       | 14.1           | -11.2     | 2.9       | 4.5            | "         | 3.6       | 9.2             | -2.7      | 6.5       |
| 20               | 23.5           | -13.1     | 10.4      | 28.3           | -20.3     | 8.0       | 19.7           | -13.6     | 6.1       | 15.0           | -12.0     | 3.0       | 4.7            | -1.0      | 3.7       | 8.6             | -2.8      | 5.8       |
| 21               | 23.4           | -13.2     | 10.2      | 29.5           | -20.4     | 9.1       | 21.3           | -14.2     | 7.1       | 15.0           | -12.0     | 3.0       | 4.7            | "         | 3.7       | 8.2             | -2.9      | 5.3       |
| 22               | 24.1           | -13.3     | 10.8      | 30.3           | -20.6     | 9.7       | 21.3           | -14.2     | 7.1       | 15.0           | -12.0     | 3.0       | 5.2            | -1.1      | 4.1       | 8.7             | -3.0      | 5.7       |
| 23               | 24.3           | -13.2     | 11.1      | 31.0           | -20.8     | 10.2      | 24.2           | -14.7     | 9.5       | 15.0           | -12.0     | 3.0       | 7.2            | -1.2      | 6.0       | 9.7             | "         | 6.6       |
| 24               | 24.1           | -13.5     | 10.6      | 31.3           | -21.0     | 10.3      | 24.2           | -14.7     | 9.5       | 15.0           | -12.0     | 3.0       | 10.2           | "         | 9.0       | 10.2            | -3.2      | 7.0       |
| 25               | 23.2           | -13.7     | 9.5       | 31.5           | -21.2     | 10.3      | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 11.2           | -1.3      | 9.9       | 11.2            | -3.3      | 7.9       |
| 26               | 21.6           | -13.9     | 7.7       | 28.5           | -21.7     | 6.8       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 12.8           | "         | 11.5      | 11.9            | -3.5      | 8.4       |
| 27               | 18.9           | -14.1     | 4.8       | 27.5           | -22.0     | 5.5       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 13.0           | -1.4      | 11.6      | 12.2            | "         | 8.7       |
| 28               | 17.2           | -14.2     | 3.0       | 24.7           | -22.4     | 2.3       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 13.2           | "         | 11.8      | 12.9            | -3.6      | 9.3       |
| 29               | 16.5           | -14.5     | 1.0       | 24.9           | -22.9     | 2.0       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 13.1           | -1.5      | 11.6      | 12.7            | -3.7      | 9.0       |
| 30               | 16.1           | -14.4     | 1.7       | 24.7           | -22.7     | 2.0       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 12.4           | "         | 10.9      | 13.0            | -3.8      | 9.2       |
| 31               | 15.8           | -14.6     | 1.2       | 25.0           | -23.1     | 1.9       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 11.1           | -1.6      | 9.5       | 12.6            | -4.0      | 8.6       |
| 32               | 16.0           | -14.7     | 1.9       | 24.7           | -23.3     | 1.4       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 9.8            | "         | 8.2       | 11.2            | -4.1      | 7.1       |
| 33               | 17.1           | -14.8     | 2.3       | 24.7           | -23.5     | 1.2       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       | 8.2            | -1.7      | 6.5       | 9.5             | -4.2      | 5.3       |
| 34               | 18.9           | -15.0     | 3.9       | 25.1           | -23.9     | 1.2       | 24.5           | -14.8     | 9.7       | 15.0           | -12.0     | 3.0       |                |           |           |                 |           |           |

Fath. Feet. Inch. Reg.  
 Dec. 5. Sounding at noon 7 1 0 20, changed to 19. } On these days the corrections deduced  
 " 6. " " 6 5 0 25 } by enveloping curves or soundings  
 " 7. " " 6 4 0 11.1, changed to 16. } agree very well.  
 " 8. " " 6 3 7 13.6  
 " 9. " " 6 4 0 7.6 (The mean of the two readings is 8.0.)  
 " 10. " " 6 4 0 9.7 ( 9.8.)

From the 9th to the 18th of December the corrections deduced from curves and soundings differ by a constant of nearly 4 feet. The differences are partly due to imperfect soundings, partly to sudden changes of the pulley-gauge (see readings between noon and 1 P. M. on the 9th). The heights given, as corrected by the soundings and curves, are, during this period, of little value, the times being less affected. The soundings were increased by 4 feet, equal to a reading of the mean level of 32.6.

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## December, 1853.

| Mean<br>solar<br>hour. | 11th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 12th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 13th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 14th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 15th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 16th.<br>Red.<br>to<br>level. | Ref.<br>obs. |      |       |      |      |       |      |
|------------------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|------|-------|------|------|-------|------|
| 1                      | 8.2                           | -4.3         | 3.9                           | 12.2         | -8.8                          | 3.4          | 20.7                          | -14.1        | 6.6                           | 13.9         | -7.6                          | 6.3          | 15.4 | -8.5  | 6.9  | 23.7 | -10.8 | 12.4 |
| 2                      | 7.4                           | -4.4         | 3.0                           | 11.1         | -9.1                          | 2.0          | 20.3                          | -14.3        | 6.0                           | 12.9         | "                             | 5.3          | 13.7 | "     | 5.2  | 20.4 | -11.1 | 9.3  |
| 3                      | 6.8                           | -4.5         | 2.3                           | 10.2         | -9.3                          | 0.9          | 19.8                          | -14.5        | 5.3                           | 11.2         | -7.7                          | 3.5          | 12.2 | -8.6  | 3.6  | 18.5 | -11.4 | 7.1  |
| 4                      | 6.1                           | -4.6         | 1.7                           | 10.0         | -9.5                          | 0.5          | 18.9                          | -14.6        | 4.3                           | 10.2         | "                             | 2.5          | "    | "     | 2.9  | 16.0 | -11.7 | 4.3  |
| 5                      | 5.5                           | -4.7         | 1.2                           | 10.0         | -9.7                          | 0.3          | 18.2                          | -14.7        | 3.5                           | 10.0         | "                             | 2.3          | 11.3 | "     | 2.7  | 15.3 | -11.8 | 3.5  |
| 6                      | 4.8                           | -4.8         | 0.7                           | 10.2         | -9.8                          | 0.4          | 18.7                          | -14.8        | 3.9                           | 10.0         | "                             | 2.9          | 11.1 | -8.7  | 2.4  | 15.4 | -12.0 | 3.4  |
| 7                      | 4.2                           | -4.9         | 0.3                           | 10.4         | -10.0                         | 0.4          | 19.4                          | -14.9        | 4.5                           | 10.0         | "                             | 2.5          | 11.4 | "     | 2.7  | 15.9 | -12.2 | 3.7  |
| 8                      | 3.6                           | -5.0         | 0.8                           | 12.9         | -10.2                         | 2.7          | 20.8                          | -15.1        | 5.7                           | 10.6         | -7.8                          | 2.8          | 11.7 | "     | 3.0  | 16.1 | -12.3 | 3.8  |
| 9                      | 3.0                           | -5.1         | 1.3                           | 15.5         | -10.4                         | 5.1          | 22.5                          | -15.3        | 7.2                           | 12.1         | "                             | 4.3          | 12.9 | "     | 4.1  | 17.2 | -12.6 | 4.0  |
| 10                     | 2.4                           | -5.2         | 1.8                           | 18.0         | -10.7                         | 7.3          | 24.7                          | -15.5        | 9.2                           | 15.1         | -7.9                          | 7.2          | 15.2 | "     | 6.4  | 19.1 | -12.9 | 6.2  |
| 11                     | 1.8                           | -5.3         | 2.3                           | 20.7         | -10.9                         | 9.8          | 26.7                          | -15.7        | 10.0                          | 17.2         | "                             | 9.3          | 17.8 | -8.9  | 8.9  | 21.2 | -13.4 | 7.8  |
| 12                     | 1.2                           | -5.4         | 2.8                           | 23.2         | -11.1                         | 12.3         | 28.7                          | -15.9        | 10.8                          | 19.4         | -8.0                          | 11.4         | 19.6 | "     | 10.7 | 24.0 | -13.7 | 10.3 |
| 13                     | 0.6                           | -5.5         | 3.3                           | 25.7         | -11.2                         | 14.8         | 30.7                          | -16.1        | 11.6                          | 21.5         | "                             | 12.2         | 20.5 | "     | 11.6 | 26.0 | -14.1 | 11.9 |
| 14                     | 0.0                           | -5.6         | 3.8                           | 28.2         | -11.3                         | 17.3         | 32.7                          | -16.3        | 12.4                          | 23.6         | -8.1                          | 11.5         | 21.0 | -9.0  | 12.0 | 27.3 | -14.5 | 12.8 |
| 15                     | -0.6                          | -5.7         | 4.3                           | 30.7         | -11.4                         | 19.8         | 34.7                          | -16.5        | 13.2                          | 25.6         | "                             | 12.2         | 22.0 | "     | 13.0 | 27.5 | -14.7 | 12.8 |
| 16                     | -1.2                          | -5.8         | 4.8                           | 33.2         | -11.5                         | 22.3         | 36.7                          | -16.7        | 14.0                          | 27.6         | "                             | 10.1         | 22.3 | -9.1  | 13.2 | 27.3 | -14.8 | 12.5 |
| 17                     | -1.8                          | -5.9         | 5.3                           | 35.7         | -11.6                         | 24.8         | 38.7                          | -16.9        | 14.8                          | 29.6         | "                             | 8.1          | 20.1 | -9.2  | 10.9 | 28.0 | -15.1 | 10.9 |
| 18                     | -2.4                          | -6.0         | 5.8                           | 38.2         | -11.7                         | 27.3         | 40.7                          | -17.1        | 15.6                          | 31.6         | -8.2                          | 5.6          | 17.6 | -9.3  | 8.3  | 23.1 | -15.3 | 7.8  |
| 19                     | -3.0                          | -6.1         | 6.3                           | 40.7         | -11.8                         | 29.8         | 42.7                          | -17.3        | 16.4                          | 33.6         | "                             | 3.3          | 16.2 | -9.4  | 6.8  | 21.0 | -15.5 | 5.5  |
| 20                     | -3.6                          | -6.2         | 6.8                           | 43.2         | -11.9                         | 32.3         | 44.7                          | -17.5        | 17.2                          | 35.6         | "                             | 2.9          | 15.4 | "     | 5.9  | "    | "     | "    |
| 21                     | -4.2                          | -6.3         | 7.3                           | 45.7         | -12.0                         | 34.8         | 46.7                          | -17.7        | 18.0                          | 37.6         | "                             | 2.6          | 15.4 | -9.5  | 6.1  | 18.3 | -15.6 | 2.7  |
| 22                     | -4.8                          | -6.4         | 7.8                           | 48.2         | -12.1                         | 37.3         | 48.7                          | -17.9        | 18.8                          | 39.6         | -8.5                          | 2.4          | 15.1 | -9.6  | 5.5  | 17.6 | -15.8 | 1.8  |
| 23                     | -5.4                          | -6.5         | 8.3                           | 50.7         | -12.2                         | 39.8         | 50.7                          | -18.1        | 19.6                          | 41.6         | "                             | 2.1          | 15.2 | "     | 5.6  | 17.5 | "     | 1.7  |
| 24                     | -6.0                          | -6.6         | 8.8                           | 53.2         | -12.3                         | 42.3         | 52.7                          | -18.3        | 20.4                          | 43.6         | "                             | 1.8          | 15.7 | -9.7  | 6.0  | 17.5 | -15.9 | 1.6  |
| 25                     | -6.6                          | -6.7         | 9.3                           | 55.7         | -12.4                         | 44.8         | 54.7                          | -18.5        | 21.2                          | 45.6         | "                             | 1.5          | 16.8 | -9.8  | 7.0  | 17.7 | -16.0 | 1.7  |
| 26                     | -7.2                          | -6.8         | 9.8                           | 58.2         | -12.5                         | 47.3         | 56.7                          | -18.7        | 22.0                          | 47.6         | "                             | 1.2          | 17.8 | -9.9  | 8.9  | 19.7 | -16.1 | 3.6  |
| 27                     | -7.8                          | -6.9         | 10.3                          | 60.7         | -12.6                         | 49.8         | 58.7                          | -18.9        | 22.8                          | 49.6         | "                             | 0.9          | 18.9 | -10.1 | 11.1 | 21.5 | -16.2 | 5.3  |
| 28                     | -8.4                          | -7.0         | 10.8                          | 63.2         | -12.7                         | 52.3         | 60.7                          | -19.1        | 23.6                          | 51.6         | "                             | 0.6          | 19.9 | -10.2 | 12.1 | 23.1 | -16.3 | 5.8  |
| 29                     | -9.0                          | -7.1         | 11.3                          | 65.7         | -12.8                         | 54.8         | 62.7                          | -19.3        | 24.4                          | 53.6         | "                             | 0.3          | 20.9 | -10.3 | 12.5 | "    | "     | "    |
| 30                     | -9.6                          | -7.2         | 11.8                          | 68.2         | -12.9                         | 57.3         | 64.7                          | -19.5        | 25.2                          | 55.6         | "                             | 0.0          | 21.9 | -10.4 | 12.5 | 23.8 | -16.4 | 7.4  |
| 31                     | -10.2                         | -7.3         | 12.3                          | 70.7         | -13.0                         | 59.8         | 66.7                          | -19.7        | 26.0                          | 57.6         | "                             | 0.0          | 22.9 | -10.5 | 12.5 | "    | "     | "    |
| 32                     | -10.8                         | -7.4         | 12.8                          | 73.2         | -13.1                         | 62.3         | 68.7                          | -19.9        | 26.8                          | 59.6         | "                             | 0.0          | 23.9 | -10.6 | 12.5 | "    | "     | "    |
| 33                     | -11.4                         | -7.5         | 13.3                          | 75.7         | -13.2                         | 64.8         | 70.7                          | -20.1        | 27.6                          | 61.6         | "                             | 0.0          | 24.9 | -10.7 | 12.5 | "    | "     | "    |
| 34                     | -12.0                         | -7.6         | 13.8                          | 78.2         | -13.3                         | 67.3         | 72.7                          | -20.3        | 28.4                          | 63.6         | "                             | 0.0          | 25.9 | -10.8 | 12.5 | "    | "     | "    |
| 35                     | -12.6                         | -7.7         | 14.3                          | 80.7         | -13.4                         | 69.8         | 74.7                          | -20.5        | 29.2                          | 65.6         | "                             | 0.0          | 26.9 | -10.9 | 12.5 | "    | "     | "    |
| 36                     | -13.2                         | -7.8         | 14.8                          | 83.2         | -13.5                         | 72.3         | 76.7                          | -20.7        | 30.0                          | 67.6         | "                             | 0.0          | 27.9 | -11.0 | 12.5 | "    | "     | "    |
| 37                     | -13.8                         | -7.9         | 15.3                          | 85.7         | -13.6                         | 74.8         | 78.7                          | -20.9        | 30.8                          | 69.6         | "                             | 0.0          | 28.9 | -11.1 | 12.5 | "    | "     | "    |
| 38                     | -14.4                         | -8.0         | 15.8                          | 88.2         | -13.7                         | 77.3         | 80.7                          | -21.1        | 31.6                          | 71.6         | "                             | 0.0          | 29.9 | -11.2 | 12.5 | "    | "     | "    |
| 39                     | -15.0                         | -8.1         | 16.3                          | 90.7         | -13.8                         | 79.8         | 82.7                          | -21.3        | 32.4                          | 73.6         | "                             | 0.0          | 30.9 | -11.3 | 12.5 | "    | "     | "    |
| 40                     | -15.6                         | -8.2         | 16.8                          | 93.2         | -13.9                         | 82.3         | 84.7                          | -21.5        | 33.2                          | 75.6         | "                             | 0.0          | 31.9 | -11.4 | 12.5 | "    | "     | "    |
| 41                     | -16.2                         | -8.3         | 17.3                          | 95.7         | -14.0                         | 84.8         | 86.7                          | -21.7        | 34.0                          | 77.6         | "                             | 0.0          | 32.9 | -11.5 | 12.5 | "    | "     | "    |
| 42                     | -16.8                         | -8.4         | 17.8                          | 98.2         | -14.1                         | 87.3         | 88.7                          | -21.9        | 34.8                          | 79.6         | "                             | 0.0          | 33.9 | -11.6 | 12.5 | "    | "     | "    |
| 43                     | -17.4                         | -8.5         | 18.3                          | 100.7        | -14.2                         | 89.8         | 90.7                          | -22.1        | 35.6                          | 81.6         | "                             | 0.0          | 34.9 | -11.7 | 12.5 | "    | "     | "    |
| 44                     | -18.0                         | -8.6         | 18.8                          | 103.2        | -14.3                         | 92.3         | 92.7                          | -22.3        | 36.4                          | 83.6         | "                             | 0.0          | 35.9 | -11.8 | 12.5 | "    | "     | "    |
| 45                     | -18.6                         | -8.7         | 19.3                          | 105.7        | -14.4                         | 94.8         | 94.7                          | -22.5        | 37.2                          | 85.6         | "                             | 0.0          | 36.9 | -11.9 | 12.5 | "    | "     | "    |
| 46                     | -19.2                         | -8.8         | 19.8                          | 108.2        | -14.5                         | 97.3         | 96.7                          | -22.7        | 38.0                          | 87.6         | "                             | 0.0          | 37.9 | -12.0 | 12.5 | "    | "     | "    |
| 47                     | -19.8                         | -8.9         | 20.3                          | 110.7        | -14.6                         | 99.8         | 98.7                          | -22.9        | 38.8                          | 89.6         | "                             | 0.0          | 38.9 | -12.1 | 12.5 | "    | "     | "    |
| 48                     | -20.4                         | -9.0         | 20.8                          | 113.2        | -14.7                         | 102.3        | 100.7                         | -23.1        | 39.6                          | 91.6         | "                             | 0.0          | 39.9 | -12.2 | 12.5 | "    | "     | "    |
| 49                     | -21.0                         | -9.1         | 21.3                          | 115.7        | -14.8                         | 104.8        | 102.7                         | -23.3        | 40.4                          | 93.6         | "                             | 0.0          | 40.9 | -12.3 | 12.5 | "    | "     | "    |
| 50                     | -21.6                         | -9.2         | 21.8                          | 118.2        | -14.9                         | 107.3        | 104.7                         | -23.5        | 41.2                          | 95.6         | "                             | 0.0          | 41.9 | -12.4 | 12.5 | "    | "     | "    |
| 51                     | -22.2                         | -9.3         | 22.3                          | 120.7        | -15.0                         | 109.8        | 106.7                         | -23.7        | 42.0                          | 97.6         | "                             | 0.0          | 42.9 | -12.5 | 12.5 | "    | "     | "    |
| 52                     | -22.8                         | -9.4         | 22.8                          | 123.2        | -15.1                         | 112.3        | 108.7                         | -23.9        | 42.8                          | 99.6         | "                             | 0.0          | 43.9 | -12.6 | 12.5 | "    | "     | "    |
| 53                     | -23.4                         | -9.5         | 23.3                          | 125.7        | -15.2                         | 114.8        | 110.7                         | -24.1        | 43.6                          | 101.6        | "                             | 0.0          | 44.9 | -12.7 | 12.5 | "    | "     | "    |
| 54                     | -24.0                         | -9.6         | 23.8                          | 128.2        | -15.3                         | 117.3        | 112.7                         | -24.3        | 44.4                          | 103.6        | "                             | 0.0          | 45.9 | -12.8 | 12.5 | "    | "     | "    |
| 55                     | -24.6                         | -9.7         | 24.3                          | 130.7        | -15.4                         | 119.8        | 114.7                         | -24.5        | 45.2                          | 105.6        | "                             | 0.0          | 46.9 | -12.9 | 12.5 | "    | "     | "    |
| 56                     | -25.2                         | -9.8         | 24.8                          | 133.2        | -15.5                         | 122.3        | 116.7                         | -24.7        | 46.0                          | 107.6        | "                             | 0.0          | 47.9 | -13.0 | 12.5 | "    | "     | "    |
| 57                     | -25.8                         | -9.9         | 25.3                          | 135.7        | -15.6                         | 124.8        | 118.7                         | -24.9        | 46.8                          | 109.6        | "                             | 0.0          | 48.9 | -13.1 | 12.5 | "    | "     | "    |
| 58                     | -26.4                         | -10.0        | 25.8                          | 138.2        | -15.7                         | 127.3        | 120.7                         | -25.1        | 47.6                          | 111.6        | "                             | 0.0          | 49.9 | -13.2 | 12.5 | "    | "     | "    |
| 59                     | -27.0                         | -10.1        | 26.3                          | 140.7        | -15.8                         | 129.8        | 122.7                         | -25.3        | 48.4                          | 113.6        | "                             | 0.0          | 50.9 | -13.3 | 12.5 | "    | "     | "    |
| 60                     | -27.6                         | -10.2        | 26.8                          | 143.2        | -15.9                         | 132.3        | 124.7                         | -25.5        | 49.2                          | 115.6        | "                             | 0.0          | 51.9 | -13.4 | 12.5 | "    | "     | "    |
| 61                     | -28.2                         | -10.3        | 27.3                          | 145.7        | -16.0                         | 134.8        | 126.7                         | -25.7        | 50.0                          | 117.6        | "                             | 0.0          | 52.9 | -13.5 | 12.5 | "    | "     | "    |
| 62                     | -28.8                         | -10.4        | 27.8                          | 148.2        | -16.1                         | 137.3        | 128.7                         | -25.9        | 50.8                          | 119.6        | "                             | 0.0          | 53.9 | -13.6 | 12.5 | "    | "     | "    |
| 63                     | -29.4                         | -10.5        | 28.3                          | 150.7        | -16.2                         | 139.8        | 130.7                         | -26.1        | 51.6                          | 121.6        | "                             | 0.0          | 54.9 | -13.7 | 12.5 | "    | "     | "    |
| 64                     | -30.0                         | -10.6        | 28.8                          | 153.2        | -16.3                         | 142.3        | 132.7                         | -26.3        | 52.4                          | 123.6        | "                             | 0.0          | 55.9 | -13.8 | 12.5 | "    | "     | "    |
| 65                     | -30.6                         | -10.7        | 29.3                          | 155.7        | -16.4                         | 144.8        | 134.7                         | -26.5        | 53.2                          | 125.6        | "                             | 0.0          | 56.9 | -13.9 | 12.5 | "    | "     | "    |
| 66                     | -31.2                         | -10.8        | 29.8                          | 158.2        | -16.5                         | 147.3        | 136.7                         | -26.7        | 54.0                          | 127.6        | "                             | 0.0          | 57.9 | -14.0 | 12.5 | "    | "     | "    |
| 67                     | -31.8                         | -10.9        | 30.3                          | 160.7        | -16.6                         | 149.8        | 138.7                         | -26.9        | 54.8                          | 129.6        | "                             | 0.0          | 58.9 | -14.1 | 12.5 | "    | "     | "    |
| 68                     | -32.4                         | -11.0        | 30.8                          | 163.2        | -16.7                         | 152.3        | 140.7                         | -27.1        | 55.6                          | 131.6        | "                             | 0.0          | 59.9 | -14.2 | 12.5 | "    | "     | "    |
| 69                     | -33.0                         | -11.1        | 31.3                          | 165.7        | -16.8                         | 154.8        | 142.7                         | -27.3        | 56.4                          | 133.6        | "                             | 0.0          | 60.9 | -14.3 | 12.5 | "    | "     | "    |
| 70                     | -33.6                         | -11.2        | 31.8                          | 168.2        | -16.9                         | 157.3        | 144.7                         | -27.5        | 57.2                          | 135.6        | "                             | 0.0          | 61.9 | -14.4 | 12.5 | "    | "     | "    |
| 71                     | -34.2                         | -11.3        | 32.3                          | 170.7        | -17.0                         | 159.8        | 146.7                         | -27.7        | 58.0                          | 137.6        | "                             | 0.0          | 62.9 | -14.5 | 12.5 | "    | "     | "    |
| 72                     | -34.8                         | -11.4        | 32.8                          | 173.2        | -17.1                         | 162.3        | 148.7                         | -27.9        | 58.8                          | 139.6        | "                             | 0.0          | 63.9 | -14.6 | 12.5 | "    | "     | "    |
| 73                     | -35.4                         | -11.5        | 33.3                          | 175.7        | -17.2                         | 164.8        | 150.7                         | -28.1        | 59.6                          | 141.6        | "                             | 0.0          | 64.9 | -14.7 | 12.5 | "    | "     | "    |
| 74                     | -36.0                         | -11.6        | 33.8                          | 178.2        | -17.3                         | 167.3        | 152.7                         | -28.3        | 60.4                          | 143.6        | "                             | 0.0          | 65.9 | -14.8 | 12.5 | "    | "     | "    |

## SER. I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 28, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## December, 1853.

| Mean solar hour. | 17th. * | Red. to level. | Ref. obs. | 18th. * | Red. to level. | Ref. obs. | 19th. * | Red. to level. | Ref. obs. | 20th. * | Red. to level. | Ref. obs. | 21st. * | Red. to level. | Ref. obs. | 22d. * | Red. to level. | Ref. obs. |
|------------------|---------|----------------|-----------|---------|----------------|-----------|---------|----------------|-----------|---------|----------------|-----------|---------|----------------|-----------|--------|----------------|-----------|
| 1                | 24.0    | -16.5          | 7.5       | 23.4    | -17.6          | 5.8       | 4.1     | +3.0           | 7.1       | 14.5    | -3.9           | 10.6      | 20.4    | -10.7          | 9.7       | 20.6   | -13.7          | 6.9       |
| 2                | 23.8    | -16.7          | 7.1       | 23.2    | "              | 5.6       | 5.7     | +2.5           | 8.2       | 15.1    | -4.4           | 10.9      | 21.4    | -11.0          | 10.4      | 21.6   | "              | 7.0       |
| 3                | 22.9    | "              | 6.2       | 21.7    | "              | 5.0       | "       | +2.2           | 7.2       | 15.2    | -4.5           | 10.7      | 22.9    | -11.3          | 11.0      | 23.2   | "              | 8.5       |
| 4                | 21.5    | -16.8          | 4.7       | 20.2    | "              | 2.6       | 3.7     | +2.0           | 5.7       | 13.5    | -4.8           | 8.7       | 21.3    | -11.6          | 9.7       | 22.5   | -13.8          | 8.7       |
| 5                | 20.5    | "              | 3.7       | 21.3    | "              | 3.7       | 2.1     | +1.8           | 3.9       | 12.2    | -5.2           | 7.0       | 21.0    | -11.9          | 9.1       | 22.3   | "              | 8.5       |
| 6                | 19.6    | -16.9          | 2.7       | 20.0    | "              | 2.4       | 1.4     | +1.6           | 3.0       | 10.5    | -5.5           | 5.0       | 19.3    | -12.2          | 7.1       | 21.7   | "              | 7.9       |
| 7                | 19.7    | "              | 2.8       | 19.3    | "              | 1.7       | 1.1     | +1.4           | 2.5       | "       | "              | "         | "       | "              | "         | "      | "              | "         |
| 8                | 20.2    | "              | 3.3       | 19.5    | "              | 0.9       | 1.1     | +1.3           | 2.4       | 10.1    | -5.8           | 4.3       | 18.3    | -12.4          | 6.0       | 20.9   | "              | 7.1       |
| 9                | 21.7    | -17.0          | 4.7       | 20.4    | -17.6          | 2.8       | 1.6     | +1.1           | 2.0       | 9.6     | -6.1           | 3.5       | 17.8    | -12.6          | 5.2       | 19.3   | -13.9          | 5.4       |
| 10               | 25.0    | "              | 8.0       | 4.3     | ?              | ---       | 2.9     | +0.8           | 3.7       | 8.0     | -6.4           | 1.6       | 17.4    | -12.8          | 4.6       | 19.0   | "              | 5.1       |
| 11               | 27.7    | -17.1          | 10.6      | 7.8     | "              | ---       | 5.0     | +0.6           | 5.6       | 9.5     | -6.5           | 2.2       | 18.3    | -13.0          | 5.3       | 19.3   | "              | 5.4       |
| 12               | 28.8    | "              | 11.7      | 8.3     | "              | ---       | 7.1     | "              | 7.4       | 11.3    | -7.1           | 4.2       | 19.5    | -13.2          | 6.3       | 20.3   | "              | 6.4       |
| 13               | 29.7    | -17.2          | 12.5      | "       | "              | ---       | 8.2     | 0.0            | 8.2       | 13.1    | -7.5           | 5.6       | 21.2    | -13.4          | 7.8       | 21.7   | -14.0          | 7.7       |
| 14               | 23.0    | "              | 10.9      | "       | "              | ---       | 8.2     | 0.0            | 8.2       | 13.1    | -7.5           | 5.6       | 21.2    | -13.4          | 7.8       | 21.7   | -14.0          | 7.7       |
| 15               | 21.8    | "              | 12.4      | "       | "              | ---       | 10.4    | -0.2           | 10.2      | 16.9    | -7.7           | 9.2       | 27.7    | "              | ---       | 23.0   | "              | 9.0       |
| 16               | 20.0    | "              | 12.5      | "       | "              | ---       | 10.7    | -0.5           | 10.2      | 18.2    | -7.9           | 10.3      | 24.4    | -13.4          | 11.0      | 24.5   | -14.1          | 10.4      |
| 17               | 18.6    | "              | 10.6      | -0.8    | 9.8            | 18.5      | -8.2    | 10.3           | 25.0      | "       | "              | "         | 24.7    | -13.5          | 11.2      | 25.3   | -14.2          | 11.1      |
| 18               | 18.5    | -17.9          | 0.9       | 18.3    | "              | 9.0       | -1.0    | 8.0            | 17.9      | -8.3    | 9.6            | 25.0      | "       | 11.5           | 25.0      | "      | 10.8           |           |
| 19               | 18.3    | "              | 0.7       | 18.3    | "              | 8.2       | -1.2    | 7.0            | 17.0      | -8.5    | 8.5            | 23.5      | "       | 10.0           | 25.9      | "      | 11.5           |           |
| 20               | 18.2    | "              | 0.6       | 18.2    | "              | 8.5       | -1.5    | 7.0            | 15.6      | -8.7    | 6.9            | 22.1      | "       | 8.6            | 24.3      | -14.5  | 9.8            |           |
| 21               | 18.3    | "              | 0.7       | 18.3    | "              | 7.7       | -1.7    | 6.0            | 16.6      | -9.1    | 7.5            | 20.2      | "       | 6.7            | 22.5      | -14.6  | 7.9            |           |
| 22               | 18.3    | "              | 15.2      | ?       | ?              | ---       | 7.6     | -1.9           | 5.7       | "       | "              | "         | "       | "              | "         | "      | "              | "         |
| 23               | 18.3    | "              | 15.4      | "       | "              | ---       | 7.8     | -2.0           | 5.6       | 17.0    | -9.4           | 7.6       | 19.3    | -13.6          | 5.7       | 21.0   | -14.7          | 6.3       |
| 24               | 18.8    | "              | 16.0      | "       | "              | ---       | 10.4    | -2.4           | 8.0       | 17.0    | -9.7           | 7.3       | 18.0    | "              | 4.4       | 20.8   | -14.8          | 6.0       |
| 25               | 19.4    | "              | 16.0      | "       | "              | ---       | 11.6    | -2.8           | 8.8       | 17.6    | -10.0          | 7.6       | 18.0    | "              | 4.4       | 19.8   | -14.9          | 4.9       |
| 26               | 20.8    | "              | 17.6      | "       | "              | ---       | 13.6    | -3.2           | 10.4      | 18.2    | -10.2          | 8.0       | 19.2    | "              | 5.6       | 19.2   | -15.0          | 4.2       |
| 27               | 21.9    | "              | 20.2      | "       | "              | ---       | 13.6    | -3.2           | 10.4      | 18.2    | -10.2          | 8.0       | 19.2    | "              | 5.6       | 19.4   | "              | 4.5       |
| 28               | 23.3    | -17.6          | 5.7       | 23.2    | -17.0          | 6.2       | 15.7    | -3.6           | 12.1      | 18.9    | -10.4          | 8.5       | 19.5    | -13.7          | 5.8       | 19.8   | -15.1          | 4.7       |
| Midn't           | 23.3    | -17.6          | 5.7       | 23.2    | -17.0          | 6.2       | 15.7    | -3.6           | 12.1      | 18.9    | -10.4          | 8.5       | 19.5    | -13.7          | 5.8       | 19.8   | -15.1          | 4.7       |

Fath. Feet. Inch. Register.

Dec. 17. Sounding at noon 7 5 0 30.0 changed to 23.0.

\* Results doubtful.

" 18. " " 7 5 3 31.3 (=11.3). Tide register broke down at 2 1/2 P.M.; was repaired and observations commenced at 7 P.M.

" 19. No sounding taken.

" 20. " "

" 21. Sounding at noon 7 3 6 21.5. Correction at noon by soundings 12.3, by curves 14.5,

" 22. " " 7 3 6 21.7. Mean correction -14.0.

[mean adopted.

The heights on the 18th and 19th have been rejected.

## SERIES I.—TIDAL OBSERVATIONS FROM OCTOBER 10, 1853, TO DECEMBER 23, 1853.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## December, 1853.

| Mean<br>solar<br>hour | 24th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 25th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 26th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 27th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 28th.<br>Red.<br>to<br>level. | Ref.<br>obs. |
|-----------------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|
| 1                     | 20.0                          | -15.2        | 4.8                           | 19.1         | -16.0                         | 3.1          | 19.5                          | "            | 2.7                           |              |
|                       |                               |              |                               |              |                               |              | 19.3                          | -16.9        | 2.4                           | 1.9          |
| 2                     | 21.1                          | -15.3        | 5.8                           | 19.7         | "                             | 3.7          | 19.6                          | -17.0        | 2.6                           | 1.8          |
|                       |                               |              |                               |              |                               |              | 1.9                           | "            | 3.2                           | 2.3          |
| 3                     | 22.0                          | -15.4        | 6.6                           | 21.0         | "                             | 5.0          | 20.3                          | -17.1        | 3.2                           | 2.1          |
|                       |                               |              |                               |              |                               |              | 2.1                           | +1.3         | 3.4                           | 3.5          |
| 4                     | 22.7                          | -15.5        | 7.2                           | 21.7         | -15.9                         | 5.8          | 21.8                          | -17.2        | 4.6                           | 3.2          |
|                       |                               |              |                               |              |                               |              | 3.2                           | +1.2         | 4.4                           | 3.0          |
| 5                     | 23.0                          | -15.6        | 7.4                           | 22.0         | "                             | 6.1          | 23.4                          | -17.3        | 6.1                           | 5.6          |
|                       |                               |              |                               |              |                               |              | 5.6                           | "            | 6.8                           | 4.7          |
| 6                     | 23.1                          | -15.7        | 7.4                           | 23.4         | "                             | 7.5          | 24.9                          | -17.4        | 7.5                           | 6.7          |
|                       |                               |              |                               |              |                               |              | 6.7                           | +1.0         | 7.7                           | 6.6          |
| 7                     | 23.0                          | -15.8        | 7.2                           | 23.6         | -15.8                         | 7.8          | 25.3                          | -17.5        | 7.8                           | 8.2          |
|                       |                               |              |                               |              |                               |              | 8.2                           | +0.9         | 9.1                           | 8.5          |
| 8                     | 23.4                          | -15.9        | 6.5                           | 23.9         | "                             | 7.1          | 25.5                          | -17.6        | 8.0                           | 8.7          |
|                       |                               |              |                               |              |                               |              | 8.0                           | +0.8         | 10.0                          | 10.6         |
| 9                     | 21.9                          | -16.0        | 5.9                           | 22.3         | "                             | 6.5          | 25.4                          | "            | 7.5                           | 9.8          |
|                       |                               |              |                               |              |                               |              | 7.5                           | +0.7         | 10.5                          | 11.9         |
| 10                    | 20.6                          | -16.1        | 4.5                           | 21.2         | "                             | 5.4          | 23.6                          | -17.7        | 5.9                           | 8.5          |
|                       |                               |              |                               |              |                               |              | 8.5                           | "            | 9.2                           | 12.2         |
| 11                    | 19.4                          | -16.2        | 3.2                           | 21.0         | "                             | 5.2          | 22.9                          | -17.8        | 5.1                           | 6.7          |
|                       |                               |              |                               |              |                               |              | 5.1                           | +0.6         | 7.3                           | 11.6         |
| Noon                  | 20.4                          | -16.3        | 4.1                           | 20.3         | -15.7                         | 4.6          | 22.0                          | -17.9        | 4.1                           | 5.6          |
|                       |                               |              |                               |              |                               |              | 4.1                           | +0.6         | 6.2                           | 9.2          |
| 1                     | 21.4                          | "            | 5.1                           | 21.7         | "                             | 6.0          | 22.2                          | -18.0        | 4.2                           | 4.4          |
|                       |                               |              |                               |              |                               |              | 4.4                           | "            | 5.0                           | 6.9          |
| 2                     | 22.5                          | "            | 6.2                           | 22.5         | -15.8                         | 6.7          | 22.5                          | "            | 4.5                           | 4.3          |
|                       |                               |              |                               |              |                               |              | 4.3                           | +0.5         | 4.8                           | 5.2          |
| 3                     | 23.6                          | -16.2        | 7.4                           | 23.5         | -15.9                         | 7.6          | 23.2                          | -18.1        | 5.1                           | 4.3          |
|                       |                               |              |                               |              |                               |              | 4.3                           | "            | 4.8                           | 4.4          |
| 4                     | 24.6                          | "            | 8.4                           | 24.5         | -16.0                         | 8.5          | 23.6                          | -18.2        | 5.4                           | 4.5          |
|                       |                               |              |                               |              |                               |              | 4.5                           | +0.4         | 4.9                           | 4.4          |
| 5                     | 25.0                          | "            | 8.8                           | "            | "                             | "            | "                             | "            | "                             | "            |
|                       |                               |              |                               |              |                               |              |                               |              |                               |              |
| 6                     | 24.7                          | "            | 8.5                           | 25.1         | -16.1                         | 9.0          | 24.6                          | "            | 6.4                           | 5.2          |
|                       |                               |              |                               |              |                               |              | 5.2                           | +0.3         | 5.5                           | 4.7          |
| 7                     | 24.6                          | "            | 8.4                           | 25.4         | -16.2                         | 9.2          | 25.3                          | -18.3        | 7.0                           | 6.8          |
|                       |                               |              |                               |              |                               |              | 7.0                           | "            | 7.1                           | 6.3          |
| 8                     | 23.7                          | -16.1        | 7.6                           | 25.1         | -16.3                         | 8.8          | 25.3                          | "            | 7.0                           | 8.1          |
|                       |                               |              |                               |              |                               |              | 8.1                           | +0.2         | 8.3                           | 7.8          |
| 9                     | 22.3                          | "            | 6.2                           | 24.2         | -16.4                         | 7.8          | 25.4                          | -18.4        | 7.0                           | 9.1          |
|                       |                               |              |                               |              |                               |              | 9.1                           | +0.1         | 9.2                           | 9.3          |
| 10                    | 20.1                          | "            | 4.0                           | 23.1         | -16.5                         | 6.6          | 25.0                          | "            | 6.6                           | 9.1          |
|                       |                               |              |                               |              |                               |              | 9.1                           | 0.0          | 9.1                           | 10.0         |
| 11                    | 19.4                          | "            | 3.3                           | 22.6         | -16.6                         | 6.0          | 24.1                          | -18.5        | 5.6                           | 8.1          |
|                       |                               |              |                               |              |                               |              | 8.1                           | -0.1         | 8.0                           | 10.8         |
| 12                    | 19.1                          | "            | 3.0                           | 22.1         | -16.7                         | 5.4          | 23.1                          | "            | 4.6                           | 7.2          |
|                       |                               |              |                               |              |                               |              | 7.2                           | -0.2         | 7.0                           | 10.2         |
| 13                    | 19.0                          | "            | 2.9                           | "            | "                             | "            | "                             | "            | "                             | "            |
| 14                    | 19.0                          | -16.0        | 3.0                           | 21.4         | -16.8                         | 4.6          | 22.4                          | -18.6        | 3.8                           | 5.2          |
|                       |                               |              |                               |              |                               |              | 5.2                           | -0.3         | 4.9                           | 9.0          |

Fath. Feet. Inch. Correction  
 Dec. 23. Sounding at noon 6 3 8 -16.3 mean of sounding and curves.  
 " 24. " " 6 4 8 -15.7 " " "  
 " 25. " " 6 3 0 -17.9 " " "  
 " 26. " " 7 1 0 +0.6 " " "  
 " 27. " " 7 2 0 -1.3 " " "  
 " 28. " " 7 4 6 (Ebb tide at 2½ P. M.) Correction -2.7 mean of sounding and curves; afternoon corrections from the curves. Between this date and the commencement of the second series the observations are too much affected by irregularities to be inserted.

## Series II.—TIDAL OBSERVATIONS FROM JANUARY 25 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| January, 1854.   |       |                |           |       |                |           |       |                |           |       |                | February, 1854. |      |                |           |      |                |           |
|------------------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------------|------|----------------|-----------|------|----------------|-----------|
| Mean solar hour. | 28th. | Red. to level. | Ref. obs. | 29th. | Red. to level. | Ref. obs. | 30th. | Red. to level. | Ref. obs. | 31st. | Red. to level. | Ref. obs.       | 1st. | Red. to level. | Ref. obs. | 2d.  | Red. to level. | Ref. obs. |
| 1                | 13.2  | -2.6           | 10.6      | 21.9  | -10.0          | 11.9      | 16.5  | -7.5           | 9.0       | 14.9  | -5.8           | 9.1             | 16.2 | -5.8           | 10.4      | 13.5 | -6.2           | 7.0       |
|                  | 12.8  | -2.8           | 10.0      | 21.5  | -10.1          | 11.4      | 16.2  | -7.4           | 8.8       | 15.5  | "              | 9.7             | 16.2 | -5.8           | 10.4      | 13.5 | "              | 7.1       |
| 2                | 12.0  | -3.3           | 8.7       | 19.6  | -10.2          | 10.4      | 15.0  | -7.3           | 8.3       | 14.7  | "              | 8.9             | 16.8 | -5.0           | 10.9      | 14.3 | "              | 8.1       |
| 3                | 11.0  | -3.8           | 7.2       | 17.7  | -10.3          | 7.4       | 12.8  | -7.2           | 5.6       | 14.3  | -5.7           | 8.6             | 17.0 | "              | 11.1      | 13.6 | "              | 9.4       |
| 4                | 8.8   | -4.2           | 4.6       | 16.1  | -10.4          | 5.7       | 10.5  | -7.1           | 3.4       | 11.7  | "              | 6.0             | 17.0 | "              | 11.1      | 15.0 | "              | 10.0      |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 | 16.9 | -6.0           | 10.9      | 13.2 | "              | 9.8       |
| 5                | 6.3   | -4.7           | 1.6       | 15.0  | -10.5          | 4.5       | 9.2   | -7.0           | 2.2       | 9.2   | "              | 3.5             | 12.6 | "              | 9.6       | 15.7 | "              | 9.5       |
|                  | 5.9   | -4.9           | 1.0       |       |                |           |       |                |           |       |                |                 |      |                |           |      |                |           |
| 6                | 6.2   | -5.1           | 1.1       | 12.2  | -10.6          | 1.6       | 7.4   | -6.9           | 0.5       | 6.0   | "              | 1.2             | 10.6 | -6.1           | 4.6       | 14.0 | "              | 7.8       |
|                  | 6.7   | -5.3           | 1.4       | 11.9  | "              | 1.3       | 7.4   | "              | 0.5       | 5.9   | -5.6           | 0.3             |      |                |           |      |                |           |
| 7                | 8.2   | -5.4           | 2.8       | 12.1  | -10.7          | 1.4       | 7.5   | -6.8           | 0.7       | 5.3   | "              | -0.3            | 8.5  | "              | 2.4       | 10.6 | "              | 4.4       |
|                  |       |                | 13.4      | "     |                | 2.7       | 7.8   | "              | 1.0       | 5.3   | "              | -0.3            | 7.9  | "              | 1.8       |      |                |           |
| 8                | 11.0  | -5.0           | 5.1       | 14.6  | -10.8          | 3.8       | 8.2   | -6.7           | 1.5       | 5.3   | "              | -0.3            | 7.7  | "              | 1.6       | 8.9  | "              | 2.7       |
|                  |       |                |           |       |                |           |       |                |           | 5.3   | -5.5           | -0.2            | 7.7  | "              | 1.6       | 9.1  | "              | 2.9       |
| 9                | 15.6  | -6.4           | 9.2       | 18.6  | -10.9          | 7.7       | 10.3  | -6.6           | 3.7       | 6.0   | "              | 1.4             | 7.5  | -6.2           | 1.3       | 8.2  | "              | 2.0       |
|                  |       |                |           |       |                |           |       |                |           |       |                | 8.3             | "    | 2.1            | 8.2       | "    |                |           |
| 10               | 17.7  | -7.2           | 10.5      | 20.7  | -11.0          | 9.7       | 12.2  | -6.5           | 5.7       | 10.0  | "              | 4.5             | 10.0 | "              | 3.8       | 8.7  | "              | 2.5       |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 |      |                |           |      |                |           |
| 11               | 19.9  | -8.0           | 11.9      | 23.4  | -11.1          | 12.3      | 14.3  | -6.4           | 7.9       | 13.0  | -5.4           | 7.6             | 13.0 | "              | 6.8       | 11.2 | "              | 5.0       |
| Noon             | 21.0  | -8.8           | 12.2      | 24.5  | -11.2          | 13.3      | 18.3  | -6.3           | 12.0      | 16.2  | -5.3           | 10.9            | 16.3 | -6.3           | 10.9      | 13.0 | -6.1           | 6.9       |
|                  | 21.2  | "              | 12.4      | 20.7  | -11.1          | 9.6       | 17.3  | "              | 13.0      | 17.3  | "              | 12.0            |      |                |           |      |                |           |
| 1                | 20.4  | -8.9           | 11.5      | 19.7  | -11.0          | 8.7       | 20.1  | "              | 13.8      | 18.3  | "              | 13.0            | 17.7 | "              | 11.4      | 14.6 | "              | 8.5       |
|                  |       |                |           | 19.2  | -10.9          | 8.3       | 20.2  | "              | 13.9      | 19.0  | "              | 13.7            |      |                |           |      |                |           |
| 2                | 18.8  | -9.0           | 9.8       | 18.7  | -10.8          | 7.9       | 19.7  | -6.2           | 13.5      | 18.2  | -5.4           | 12.8            | 18.4 | "              | 12.1      | 16.0 | "              | 9.9       |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 | 18.4 | "              | 12.7      | 16.0 | "              | 10.1      |
| 3                | 17.1  | -9.1           | 8.0       | 15.6  | -10.6          | 5.0       | 17.7  | -6.1           | 11.6      | 16.8  | "              | 11.4            | 19.2 | "              | 12.9      | 16.7 | "              | 10.6      |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 | 18.9 | "              | 12.6      | 16.0 | "              | 9.9       |
| 4                | 15.6  | -9.2           | 6.4       | 12.0  | -10.4          | 1.6       | 14.6  | "              | 8.5       | 15.7  | -5.5           | 10.2            | 18.2 | "              | 11.9      | 16.0 | "              | 9.9       |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 |      |                |           |      |                |           |
| 5                | 13.7  | -9.3           | 4.4       | 10.8  | -10.2          | 0.6       | 8.2   | -6.0           | 2.2       | 13.0  | "              | 7.5             | 15.8 | "              | 9.5       | 16.0 | -6.2           | 8.7       |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 |      |                |           |      |                |           |
| 6                | 12.2  | -9.4           | 2.8       | 10.0  | -10.0          | 0.0       | 6.3   | "              | 0.3       | 9.7   | -5.6           | 4.1             | 12.4 | "              | 6.1       | 13.9 | "              | 7.7       |
|                  | 12.0  | "              | 2.6       | 9.7   | -9.9           | -0.2      | 6.1   | "              | 0.1       | "     | "              | 1.7             | 10.0 | "              | 3.7       | 10.8 | "              | 4.6       |
| 7                | 12.2  | -9.5           | 2.7       | 9.2   | -9.8           | -0.6      | 5.7   | "              | -0.3      | 7.3   | "              | 1.6             | 8.7  | "              | 2.4       | 8.1  | "              | 1.9       |
|                  |       |                | 8.6       | -9.7  | -1.1           | 5.6       | -5.9  | -0.3           | 7.2       | "     | 1.6            |                 |      |                |           |      |                |           |
| 8                | 14.2  | -9.6           | 4.6       | 7.8   | -9.9           | -1.8      | 5.5   | "              | -0.4      | 7.2   | "              | 1.6             | 8.7  | "              | 2.4       | 8.1  | "              | 1.9       |
|                  |       |                | 7.7       | -9.5  | -1.8           | 5.7       | "     | -0.2           | 7.2       | -5.7  | 1.5            | 8.5             | "    | 2.2            |           |      |                |           |
| 9                | 17.1  | -9.7           | 7.4       | 8.7   | -9.4           | -0.7      | 6.7   | "              | 0.8       | 7.4   | "              | 1.7             | 8.4  | "              | 2.1       | 6.6  | "              | 0.4       |
|                  |       |                |           |       |                |           |       |                |           |       |                | 8.4             | "    | 2.1            | 6.6       | "    |                |           |
| 10               | 19.9  | -9.8           | 10.1      | 10.8  | -9.2           | 0.6       | 9.3   | "              | 3.4       | 9.0   | "              | 3.3             | 8.6  | "              | 2.3       | 6.6  | -5.3           | 0.3       |
|                  |       |                |           |       |                |           |       |                |           |       |                |                 |      |                |           | 6.6  | "              | 0.9       |
| 11               | 21.1  | -9.8           | 11.2      | 13.4  | -9.0           | 4.4       | 12.1  | "              | 6.2       | 12.6  | "              | 6.3             | 10.0 | "              | 3.7       | 7.2  | "              | 0.3       |
| Midn't           | 21.6  | -10.0          | 11.6      | 14.8  | -8.7           | 6.1       | 14.0  | -5.8           | 8.2       | 14.6  | -5.8           | 8.8             | 12.1 | -6.2           | 5.9       | 9.3  | "              | 3.0       |

Jan. 27. At 11 P. M., 13.7; at 11 30<sup>m</sup>, 13.8; at 28th, 0<sup>m</sup>, 13.9, high water; corrected high water 11.3.

Jan. 28. Sounding at noon 8 0 0 Corrected reading by sounding 11.4, by curves 13.1, mean 12.2.  
 " 29. " " 8 1 6 Index changed to 19.6. Corrected reading by sounding 12.9, by curves 13.7, mean 13.3.

" 30. " " 8 0 6 Corrected reading by sounding 11.9, by curves 12.1, mean 12.0.  
 " 31. " " " " " Corrected reading by curves 10.9.

Feb. 1. " " 7 4 6 Ebb tide at 7 1/2 A. M.

" 2. " " 7 1 0 Ebb tide at 4 P. M. (probably means ebb commences). Index 13.0.

Note to Feb. 1 and 2. The correction is derived from the soundings and curves.



## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## February, 1854.

| Mean<br>solar<br>hour. | 3d.<br>Red.<br>to<br>level. | Ref.<br>obs. | 4th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 5th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 6th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 7th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 8th.<br>Red.<br>to<br>level. | Ref.<br>obs. |      |      |      |      |      |      |     |
|------------------------|-----------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------------------------------|--------------|------|------|------|------|------|------|-----|
| 1                      | 12.0                        | -6.4         | 5.6                          | 11.2         | -6.0                         | 5.2          | 10.6                         | -5.8         | 3.8                          | 11.7         | -7.2                         | 4.5          | 9.5  | -5.2 | 4.3  | 9.7  | -4.4 | 5.3  |     |
| 2                      | 13.0                        | "            | 6.6                          | 13.0         | -5.9                         | 7.1          | 11.7                         | -7.1         | 4.6                          | 12.2         | "                            | 5.1          | 9.3  | "    | 4.1  | 9.2  | -4.5 | 4.7  |     |
| 3                      | 14.0                        | -6.5         | 7.5                          | 14.3         | "                            | 8.4          | 12.9                         | -7.2         | 5.7                          | 13.5         | -6.9                         | 6.6          | 10.2 | -5.0 | 5.2  | 9.2  | "    | 4.7  |     |
| 4                      | 15.0                        | "            | 7.9                          | 14.7         | -5.8                         | 8.9          | 13.7                         | -7.3         | 6.4                          | 13.9         | "                            | 9.0          | 11.1 | -4.9 | 6.2  | 9.2  | "    | 4.7  |     |
| 5                      | 16.0                        | "            | 8.5                          | 14.9         | "                            | 9.1          | 13.7                         | -7.3         | 6.4                          | 13.9         | "                            | 9.0          | 11.1 | -4.9 | 6.2  | 9.2  | "    | 4.7  |     |
| 6                      | 17.0                        | -6.6         | 8.2                          | 14.9         | -5.7                         | 9.2          | 17.1                         | -7.4         | 9.7                          | 16.1         | "                            | 9.1          | 12.0 | "    | 7.1  | 10.0 | "    | 5.5  |     |
| 7                      | 18.0                        | "            | 11.8                         | "            | 9.1                          | "            | 16.0                         | "            | 9.2                          | 16.0         | "                            | 9.2          | 13.0 | -4.8 | 8.2  | 11.5 | "    | 7.0  |     |
| 8                      | 19.0                        | "            | 7.3                          | 14.2         | -5.6                         | 8.6          | 17.5                         | -7.5         | 10.0                         | 16.0         | -6.7                         | 9.4          | 13.0 | -4.8 | 8.2  | 11.5 | "    | 7.0  |     |
| 9                      | 20.0                        | "            | 5.5                          | 12.8         | "                            | 7.2          | 17.7                         | -7.6         | 10.1                         | 16.0         | -6.6                         | 9.4          | 13.7 | -4.7 | 9.0  | 12.6 | -4.6 | 8.0  |     |
| 10                     | 21.0                        | "            | 4.5                          | 11.7         | -5.5                         | 6.2          | 17.4                         | -7.7         | 9.7                          | 16.0         | -6.5                         | 9.5          | 14.0 | -4.6 | 9.4  | 14.4 | "    | 8.8  |     |
| 11                     | 22.0                        | -6.7         | 3.4                          | 9.2          | -5.4                         | 3.8          | 16.3                         | -7.8         | 8.5                          | 15.2         | -6.4                         | 8.8          | 13.3 | -4.5 | 8.8  | 13.9 | "    | 9.1  |     |
| 12                     | 23.0                        | "            | 3.5                          | 9.2          | "                            | 3.8          | "                            | "            | "                            | 15.0         | "                            | 9.5          | 13.7 | "    | 9.1  | 14.0 | "    | 9.4  |     |
| 13                     | 24.0                        | "            | 4.1                          | 9.8          | -5.4                         | 4.4          | 15.5                         | -8.0         | 7.5                          | 14.4         | -6.3                         | 8.1          | 12.8 | -4.4 | 8.4  | 14.1 | "    | 9.5  |     |
| 14                     | 25.0                        | "            | 5.2                          | 10.5         | "                            | 5.1          | 15.2                         | -8.1         | 7.1                          | 13.6         | "                            | 7.3          | 12.2 | -4.3 | 7.9  | 13.9 | "    | 9.3  |     |
| 15                     | 26.0                        | "            | 6.8                          | 5.8          | 10.7                         | -5.3         | 5.4                          | 15.0         | -8.2                         | 6.8          | 10.0                         | -6.2         | 3.8  | 11.8 | -4.2 | 7.0  | 11.6 | -4.7 | 6.9 |
| 16                     | 27.0                        | "            | 6.1                          | 11.2         | -5.4                         | 5.8          | 13.7                         | -8.1         | 5.6                          | 10.5         | -6.1                         | 4.4          | 11.0 | "    | 6.8  | 10.2 | "    | 5.5  |     |
| 17                     | 28.0                        | -6.7         | 7.4                          | 12.8         | -5.5                         | 7.9          | 14.4                         | -8.0         | 6.4                          | 11.0         | -6.0                         | 5.0          | 10.0 | "    | 6.8  | 9.1  | "    | 4.4  |     |
| 18                     | 29.0                        | "            | 8.1                          | 13.5         | -5.6                         | 7.9          | 15.5                         | -7.9         | 7.6                          | 11.3         | "                            | 5.3          | 10.0 | "    | 5.8  | 8.2  | "    | 3.5  |     |
| 19                     | 30.0                        | -6.6         | 8.5                          | "            | "                            | "            | "                            | "            | "                            | 10.0         | "                            | 5.8          | 8.0  | "    | 5.8  | 8.0  | "    | 3.3  |     |
| 20                     | 31.0                        | "            | 8.6                          | 14.2         | -5.7                         | 8.5          | 17.7                         | -7.8         | 9.9                          | 12.0         | -5.9                         | 6.1          | 10.0 | "    | 5.8  | 8.0  | "    | 3.3  |     |
| 21                     | 32.0                        | "            | 6.5                          | 8.1          | 14.6                         | -7.8         | 8.8                          | 18.3         | -7.7                         | 10.5         | 12.5                         | -5.8         | 6.7  | 11.3 | -4.3 | 7.0  | 8.1  | "    | 3.4 |
| 22                     | 33.0                        | "            | 6.4                          | 14.6         | -5.9                         | 8.7          | 18.0                         | -7.6         | 10.4                         | 12.6         | -5.7                         | 6.9          | 11.4 | "    | 7.1  | 9.7  | "    | 5.0  |     |
| 23                     | 34.0                        | -6.4         | 4.8                          | 14.2         | -6.0                         | 8.2          | 17.2                         | -7.5         | 9.7                          | 12.7         | -5.6                         | 7.1          | 12.2 | "    | 7.9  | 10.2 | "    | 5.5  |     |
| 24                     | 35.0                        | -6.3         | 3.3                          | 13.5         | -6.1                         | 7.1          | 15.9                         | -7.4         | 7.6                          | 12.7         | -5.5                         | 7.2          | 12.5 | "    | 8.2  | 11.1 | "    | 6.4  |     |
| 25                     | 36.0                        | "            | 2.1                          | 12.2         | -6.2                         | 6.0          | 13.7                         | -7.3         | 6.3                          | 12.5         | -5.4                         | 7.1          | 12.0 | -4.4 | 7.6  | 11.1 | "    | 6.7  |     |
| 26                     | 37.0                        | -6.2         | 2.2                          | "            | "                            | "            | "                            | "            | "                            | 12.7         | "                            | 7.1          | 12.5 | "    | 7.9  | 11.4 | "    | 6.7  |     |
| 27                     | 38.0                        | -6.1         | 2.5                          | 11.0         | -6.1                         | 4.6          | 12.4                         | -7.3         | 5.1                          | 11.3         | "                            | 5.9          | 11.8 | "    | 7.4  | 11.4 | "    | 6.7  |     |
| 28                     | 39.0                        | "            | 2.7                          | 10.6         | -6.5                         | 4.1          | 11.9                         | "            | 4.6                          | 9.5          | -5.3                         | 4.2          | 11.2 | "    | 6.8  | 11.1 | "    | 6.4  |     |
| 29                     | 40.0                        | "            | 10.6                         | -6.6         | 4.0                          | 11.8         | "                            | 4.5          | 9.0                          | "            | 3.7                          | "            | "    | "    | "    | "    | "    | "    |     |
| 30                     | 41.0                        | -6.0         | 3.7                          | 10.6         | -6.7                         | 3.9          | 11.7                         | -7.2         | 4.5                          | 9.0          | -5.2                         | 3.8          | 10.7 | -4.4 | 6.3  | 11.0 | "    | 6.3  |     |

Fath. Feet. Inch.

|         |                  |   |   |   |                                                             |                                                             |
|---------|------------------|---|---|---|-------------------------------------------------------------|-------------------------------------------------------------|
| Feb. 3. | Sounding at noon | 6 | 5 | 6 | Corrected reading by sounding 4.9, by curves 6.7, mean 5.8. |                                                             |
| "       | 4.               | " | " | " |                                                             |                                                             |
| "       | 5.               | " | " | " |                                                             |                                                             |
| "       | 6.               | " | 6 | 4 | 0                                                           | Corrected reading by sounding 3.4, by curves 4.3, mean 3.8. |
| "       | 7.               | " | " | " | "                                                           |                                                             |
| "       | 8.               | " | 6 | 5 | 6                                                           | Corrected reading by sounding and curves 6.9.               |

## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## February, 1854.

| Mean<br>solar<br>hour. | 9th. | Red.<br>to<br>level. | Ref.<br>obs. | 10th. | Red.<br>to<br>level. | Ref.<br>obs. | 11th. | Red.<br>to<br>level. | Ref.<br>obs. | 12th. | Red.<br>to<br>level. | Ref.<br>obs. | 13th. | Red.<br>to<br>level. | Ref.<br>obs. | 14th. | Red.<br>to<br>level. | Ref.<br>obs. |
|------------------------|------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|
| 1                      | 9.9  | -4.6                 | 5.3          | 11.4  | -5.6                 | 5.8          | 10.7  | -6.3                 | 4.4          | 11.1  | -6.2                 | 4.9          | 14.7  | -6.7                 | 8.0          | 19.5  | -9.4                 | 10.1         |
| 2                      | 9.8  | "                    | 4.2          | 11.0  | -5.7                 | 5.3          | 10.1  | "                    | 3.8          | 11.1  | "                    | 4.9          | 13.6  | "                    | 6.9          | 18.5  | -9.6                 | 8.9          |
| 3                      | 8.4  | "                    | 3.8          | 10.4  | -5.8                 | 4.6          | 8.8   | "                    | 2.5          | 10.2  | "                    | 4.0          | 12.7  | -6.8                 | 5.9          | 16.0  | -9.8                 | 6.2          |
| 4                      | 8.4  | "                    | 3.8          | 10.0  | -5.9                 | 4.1          | 8.2   | "                    | 1.9          | 9.0   | "                    | 2.8          | 9.7   | "                    | 2.9          | 14.0  | -10.0                | 4.0          |
| 5                      | 8.8  | "                    | 3.8          | 10.0  | -6.0                 | 4.0          | 7.5   | -6.2                 | 1.3          | 9.2   | "                    | 3.0          | 8.2   | "                    | 1.4          | 13.7  | -10.1                | 3.6          |
| 6                      | 10.0 | "                    | 5.4          | 10.0  | -6.1                 | 3.9          | 7.5   | "                    | 1.3          | 9.0   | "                    | 2.8          | 7.6   | -6.9                 | 0.7          | 13.3  | -10.3                | 3.0          |
| 7                      | 11.6 | "                    | 7.0          | 11.0  | -6.2                 | 4.8          | 9.1   | "                    | 2.9          | 9.7   | "                    | 3.5          | 8.9   | "                    | 2.0          | 12.9  | -10.4                | 2.5          |
| 8                      | 12.8 | "                    | 8.2          | 12.8  | -6.3                 | 6.5          | 10.3  | -6.1                 | 4.2          | 11.2  | "                    | 5.0          | 10.9  | "                    | 4.0          | 14.7  | -10.6                | 3.1          |
| 9                      | 13.5 | "                    | 8.9          | 15.0  | -6.4                 | 8.6          | 12.6  | "                    | 6.5          | 13.2  | "                    | 7.0          | 13.0  | -7.0                 | 6.0          | 16.2  | -10.8                | 5.4          |
| 10                     | 14.1 | "                    | 9.5          | 15.7  | -6.5                 | 9.2          | 15.5  | "                    | 9.4          | 15.3  | "                    | 9.1          | 16.0  | "                    | 9.0          | 18.7  | -10.9                | 7.8          |
| 11                     | 14.3 | "                    | 9.7          | 15.7  | "                    | 9.2          | 16.1  | "                    | 10.0         | 15.7  | "                    | 10.4         | 16.9  | "                    | 9.9          | 20.8  | -11.1                | 9.7          |
| 12                     | 14.2 | "                    | 9.6          | 15.7  | "                    | 9.2          | 16.1  | "                    | 10.0         | 15.7  | "                    | 11.5         | 19.1  | "                    | 12.1         | 20.8  | -11.1                | 9.7          |
| 13                     | 14.8 | "                    | 9.2          | 15.0  | "                    | 8.5          | 16.4  | "                    | 10.3         | 15.4  | "                    | 11.2         | 19.5  | "                    | 12.6         | 21.7  | -11.2                | 10.5         |
| Noon                   | 12.6 | -4.5                 | 9.1          | 14.0  | -6.6                 | 7.4          | 16.5  | -6.0                 | 10.5         | 17.1  | -6.3                 | 10.8         | 19.5  | -7.1                 | 12.4         | 21.7  | -11.2                | 10.5         |
| 1                      | 14.5 | "                    | 9.0          | 13.9  | "                    | 7.3          | 15.7  | "                    | 9.7          | 16.0  | "                    | 9.7          | 19.5  | -7.2                 | 12.3         | 24.3  | -11.3                | 11.9         |
| 2                      | 12.7 | "                    | 8.2          | 13.4  | "                    | 6.8          | 13.6  | "                    | 7.6          | 14.7  | "                    | 8.4          | 17.9  | -7.5                 | 10.4         | 24.3  | -11.3                | 11.9         |
| 3                      | 11.2 | -4.6                 | 6.6          | 10.7  | "                    | 4.1          | 11.4  | "                    | 5.4          | 12.3  | -6.4                 | 5.9          | 16.7  | -7.7                 | 9.0          | 21.5  | -11.4                | 10.1         |
| 4                      | 9.0  | -4.7                 | 4.3          | 8.7   | -6.5                 | 2.2          | 9.5   | "                    | 3.5          | 10.0  | "                    | 3.6          | 16.3  | -7.9                 | 8.4          | 19.5  | -11.5                | 8.1          |
| 5                      | 8.3  | "                    | 3.6          | 8.0   | "                    | 1.5          | 8.0   | "                    | 2.0          | 9.7   | "                    | 3.3          | 12.9  | -8.1                 | 4.8          | 16.7  | -11.5                | 5.2          |
| 6                      | 8.7  | -4.8                 | 3.9          | 8.0   | "                    | 1.5          | 8.0   | "                    | 2.0          | 9.7   | "                    | 3.3          | 12.9  | -8.1                 | 4.8          | 16.7  | -11.5                | 5.2          |
| 7                      | 9.3  | "                    | 4.5          | 8.0   | "                    | 1.5          | 8.0   | "                    | 2.0          | 8.9   | -6.5                 | 2.4          | 13.1  | -8.3                 | 4.8          | 14.7  | -11.6                | 2.6          |
| 8                      | 11.0 | -5.0                 | 6.0          | 9.8   | -6.4                 | 3.4          | 10.3  | -6.1                 | 4.2          | 9.7   | "                    | 3.2          | 16.3  | -8.5                 | 7.8          | 14.6  | -11.6                | 2.6          |
| 9                      | 11.7 | -5.1                 | 6.6          | 11.2  | "                    | 4.8          | 11.4  | "                    | 5.3          | 9.9   | -6.6                 | 3.3          | 16.3  | -8.7                 | 7.6          | 15.1  | -11.7                | 4.1          |
| 10                     | 12.4 | -5.2                 | 7.2          | 12.3  | "                    | 5.9          | 12.1  | "                    | 6.0          | 12.6  | "                    | 6.0          | 18.7  | -8.8                 | 9.9          | 15.8  | -11.7                | 4.1          |
| 11                     | 12.3 | -5.3                 | 7.0          | 12.7  | "                    | 6.3          | 12.9  | "                    | 6.8          | 15.0  | "                    | 7.7          | 19.1  | -8.9                 | 10.2         | 16.6  | -11.8                | 4.9          |
| 12                     | 12.6 | -5.4                 | 7.2          | 12.7  | "                    | 6.3          | 13.3  | "                    | 7.2          | 15.0  | "                    | 8.4          | 19.5  | -9.1                 | 10.4         | 17.4  | -11.8                | 5.6          |
| Midnight               | 12.4 | -5.5                 | 6.9          | 12.9  | -6.3                 | 6.6          | 13.8  | "                    | 7.7          | 15.1  | -6.7                 | 8.4          | 19.5  | -9.2                 | 10.3         | 17.4  | -11.8                | 5.6          |

Feb. 9. No sounding.

Feb. 10. Sounding at noon

" 10. Sounding at noon 7 2 0 Corrected by sounding -6.6, by curves -6.6.

" 11. " " 7 4 6 Ebb tide at 6 P.M. Corrected by sounding -6.6, by curves -6.0, mean -6.3.

" 12. " " 8 1 6 Corrected by sounding -6.6, by curves -7.6, mean -7.1.

" 13. No sounding.

" 14. No sounding.



## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## February, 1854.

| Mean solar hour. | 21st. | Red. to level. | Ref. obs. | 22d. | Red. to level. | Ref. obs. | 23d. | Red. to level. | Ref. obs. | 24th. | Red. to level. | Ref. obs. | 25th. | Red. to level. | Ref. obs. | 26th. | Red. to level. | Ref. obs. |
|------------------|-------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|
| 1                | ---   | ---            | ---       | 10.5 | -6.0           | 4.5       | 12.4 | -7.2           | 5.2       | 14.4  | -10.9          | 3.5       | 9.8   | -2.1           | 7.7       | 10.6  | -2.2           | 8.4       |
| "                | ---   | ---            | ---       | 10.7 | "              | 4.7       | 11.8 | -7.3           | 4.5       | 14.2  | "              | 3.3       | "     | "              | 5.7       | 8.8   | -2.4           | 6.4       |
| 2                | ---   | ---            | ---       | 11.5 | "              | 5.5       | 11.8 | -7.4           | 4.4       | 14.5  | -11.0          | 3.5       | 7.8   | "              | 5.7       | "     | "              | "         |
| 3                | ---   | ---            | ---       | 12.9 | "              | 6.9       | 11.8 | -7.5           | 4.3       | "     | "              | "         | 5.8   | -2.2           | 3.6       | 6.4   | -2.7           | 3.7       |
| 4                | ---   | ---            | ---       | 14.2 | "              | 8.2       | 12.1 | -7.8           | 4.3       | 16.1  | -11.2          | 4.9       | 5.3   | "              | 3.1       | 5.2   | -3.0           | 2.2       |
| 5                | ---   | ---            | ---       | 14.1 | ?              | ---       | 14.3 | -8.2           | 6.1       | 17.2  | -11.3          | 5.9       | 15.4  | "              | 3.1       | 4.1   | -3.1           | 1.0       |
| 6                | ---   | ---            | ---       | 13.6 | "              | ---       | 15.8 | -8.3           | 7.5       | 18.3  | -11.5          | 6.8       | 5.6   | "              | 3.3       | 4.2   | -3.2           | 1.0       |
| 7                | ---   | ---            | ---       | 13.2 | "              | ---       | 16.8 | -8.5           | 8.3       | 19.4  | -11.6          | 7.8       | 7.6   | -2.4           | 5.2       | 4.7   | -3.5           | 1.2       |
| 8                | ---   | ---            | ---       | 12.7 | "              | ---       | 18.1 | -8.6           | 9.5       | 21.7  | -11.8          | 9.9       | 9.7   | "              | 7.3       | 6.6   | -3.7           | 2.9       |
| 9                | ---   | ---            | ---       | 15.0 | -6.2           | 8.8       | 15.5 | "              | 9.3       | 22.2  | -11.9          | 10.3      | 11.0  | -2.5           | 8.5       | 9.0   | -4.0           | 5.0       |
| 10               | ---   | ---            | ---       | 15.6 | "              | 9.4       | 14.9 | "              | 8.7       | 22.2  | "              | 10.3      | 12.7  | "              | 10.2      | 11.0  | -4.3           | 6.7       |
| 11               | ---   | ---            | ---       | 14.2 | "              | 8.0       | 14.9 | "              | 8.7       | 22.3  | -12.0          | 10.3      | 13.8  | -2.6           | 11.2      | 13.0  | -4.6           | 8.4       |
| Noon             | ---   | ---            | ---       | 12.8 | -6.2           | 6.6       | 14.2 | "              | 8.0       | 22.2  | -12.1          | 10.1      | 13.8  | "              | 11.2      | 14.6  | -4.9           | 9.7       |
| 1                | ---   | ---            | ---       | 12.2 | "              | 6.0       | 14.7 | -9.0           | 9.7       | 20.7  | -12.3          | 8.4       | 13.7  | -2.7           | 11.0      | 15.4  | -5.4           | 10.0      |
| 2                | ---   | ---            | ---       | 12.2 | "              | 6.0       | 16.7 | -9.3           | 8.6       | 10.0  | -1.7           | 8.3       | 11.4  | -1.9           | 9.5       | 17.5  | -5.6           | 11.9      |
| 3                | ---   | ---            | ---       | 12.2 | "              | 6.0       | 16.7 | -9.6           | 7.1       | 7.6   | "              | 5.9       | 9.0   | -1.0           | 8.0       | 15.0  | -5.8           | 9.2       |
| 4                | ---   | ---            | ---       | 12.2 | -6.3           | 5.9       | 16.1 | -9.9           | 6.2       | 6.6   | -1.8           | 4.8       | 6.0   | -1.1           | 4.9       | 13.1  | -6.0           | 7.1       |
| 5                | ---   | ---            | ---       | 12.5 | "              | 6.2       | 16.0 | -10.0          | 6.0       | 5.0   | "              | 3.2       | "     | "              | "         | "     | "              | "         |
| 6                | ---   | ---            | ---       | 11.0 | "              | 4.7       | 16.0 | -10.2          | 5.8       | 4.6   | "              | 2.8       | 4.7   | -1.3           | 3.4       | 10.2  | -6.1           | 4.1       |
| 7                | ---   | ---            | ---       | 11.7 | -6.4           | 5.3       | 16.2 | "              | 5.7       | 5.6   | "              | 3.5       | 3.3   | "              | 2.0       | 9.5   | -6.2           | 3.3       |
| 8                | ---   | ---            | ---       | 12.9 | "              | 6.5       | 16.6 | "              | 6.4       | "     | "              | 3.8       | 3.7   | -1.4           | 2.3       | 9.4   | -6.3           | 3.1       |
| 9                | ---   | ---            | ---       | 14.2 | "              | 7.8       | 17.0 | -10.3          | 6.7       | 6.4   | "              | 4.6       | 4.1   | -1.5           | 2.6       | 9.4   | -6.4           | 3.0       |
| 10               | ---   | ---            | ---       | 15.1 | -6.5           | 8.6       | 18.0 | "              | 7.7       | 7.7   | "              | 5.9       | 5.4   | -1.6           | 3.8       | 9.8   | -6.5           | 3.0       |
| 11               | 13.5  | -5.8           | 7.7       | 15.2 | "              | 8.7       | 15.2 | "              | 8.7       | 9.6   | -1.9           | 7.7       | 8.0   | -1.7           | 6.3       | 11.5  | -6.7           | 4.8       |
| Midn't           | 10.2  | "              | 4.3       | 13.8 | -7.0           | 6.8       | 16.4 | -10.8          | 5.6       | 10.6  | -2.0           | 8.6       | 12.3  | -2.0           | 10.3      | 18.4  | -7.1           | 11.3      |

Feb. 21. Readings irregular, tide-gauge out of order at 8 A. M., repaired at noon. Sounding 7 fath., 1 ft., 0 in. Feb. 22 and 23. No sounding.

Feb. 24. Sounding at noon 6 5 0 Corrections derived from curves.  
 " 25. " " 7 0 6 Ebb tide at 11 A. M. Corrections derived from curves.  
 " 26. " " 7 5 6 Correction derived from the means by sounding and curves.

## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| February, 1854. |                      |           |                      |           |                     | March, 1854. |                    |           |                    |           |                     |             |
|-----------------|----------------------|-----------|----------------------|-----------|---------------------|--------------|--------------------|-----------|--------------------|-----------|---------------------|-------------|
| Mean solar hour | 27th. Red. to level. | Ref. obs. | 28th. Red. to level. | Ref. obs. | 1st. Red. to level. | Ref. obs.    | 2d. Red. to level. | Ref. obs. | 3d. Red. to level. | Ref. obs. | 4th. Red. to level. | Ref. obs.   |
| 1               | 18.3 -7.3            | 11.0      | 14.8                 | " 9.9     | 16.3                | " 11.3       | 17.0               | " 12.0    | 15.5               | " 10.1    | 13.1                | -5.1 8.0    |
| 2               | 17.5 -7.4            | 10.1      | 12.8                 | " 7.9     | 16.3                | " 11.3       | 17.0               | " 12.0    | 16.0               | " 10.6    | 15.4                | -5.0 10.4   |
| 3               | 17.8 -7.5            | 10.3      | 11.0                 | " 6.1     | 13.9                | " 8.9        | 16.0               | " 11.0    | 16.0               | " 10.6    | 15.0                | " 10.4      |
| 4               | 19.3 " " " 7.8       | "         | 2.9                  | 12.0      | "                   | 7.0          | 15.1               | "         | 10.1               | 14.8      | -5.5 9.3            | 15.8 " 11.1 |
| 5               | 5.3 -4.8             | 0.5       | 5.5                  | " 0.6     | 10.5                | " 5.5        | 12.8               | " 7.8     | 13.6               | " 8.1     | 14.2                | -4.8 9.4    |
| 6               | 4.4 " " " 5.5        | "         | 0.6                  | 10.5      | "                   | 5.5          | 12.8               | " 7.8     | 13.6               | " 8.1     | 14.2                | -4.8 9.4    |
| 7               | 5.0 " " " 5.0        | "         | 0.1                  | 5.5       | "                   | 0.5          | 9.0                | " 4.0     | 11.1               | -5.6 5.5  | 9.7                 | -4.7 5.0    |
| 8               | 5.8 " " " 5.0        | "         | 0.1                  | 5.5       | "                   | 0.5          | 8.8                | " 3.8     | 9.1                | " 9.1     | " 4.4               | " 4.4       |
| 9               | 8.3 " " " 5.0        | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 10              | 11.1 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 11              | 14.4 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 12              | 16.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 13              | 18.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 14              | 20.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 15              | 22.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 16              | 24.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 17              | 26.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 18              | 28.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 19              | 30.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 20              | 32.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 21              | 34.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 22              | 36.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 23              | 38.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 24              | 40.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 25              | 42.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 26              | 44.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 27              | 46.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 28              | 48.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 29              | 50.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 30              | 52.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 31              | 54.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 1               | 56.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 2               | 58.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 3               | 60.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 4               | 62.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 5               | 64.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 6               | 66.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 7               | 68.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 8               | 70.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 9               | 72.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 10              | 74.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 11              | 76.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 12              | 78.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 13              | 80.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 14              | 82.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 15              | 84.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 16              | 86.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 17              | 88.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 18              | 90.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 19              | 92.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 20              | 94.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 21              | 96.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 22              | 98.3 " " " 5.0       | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 23              | 100.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 24              | 102.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 25              | 104.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 26              | 106.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 27              | 108.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 28              | 110.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 29              | 112.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 30              | 114.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 31              | 116.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 1               | 118.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 2               | 120.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 3               | 122.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 4               | 124.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 5               | 126.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 6               | 128.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 7               | 130.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 8               | 132.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 9               | 134.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 10              | 136.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 11              | 138.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 12              | 140.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 13              | 142.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 14              | 144.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 15              | 146.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 16              | 148.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 17              | 150.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 18              | 152.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 19              | 154.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 20              | 156.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 21              | 158.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 22              | 160.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 23              | 162.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 24              | 164.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 25              | 166.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 26              | 168.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 27              | 170.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 28              | 172.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 29              | 174.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 30              | 176.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 31              | 178.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 1               | 180.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 2               | 182.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 3               | 184.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 4               | 186.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 5               | 188.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 6               | 190.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 7               | 192.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 8               | 194.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 9               | 196.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 | " 3.9       |
| 10              | 198.3 " " " 5.0      | "         | 0.1                  | 5.5       | "                   | 0.5          | 7.5                | " 2.5     | 9.4                | " 3.8     | 8.6                 |             |

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

ed in units

| Red.<br>to<br>level. | Ref.<br>obs. |
|----------------------|--------------|
| -5.1                 | 8.0          |
| -5.0                 | 10.4         |
| -4.9                 | 10.9         |
| "                    | 11.1         |
| "                    | 11.1         |
| "                    | 10.9         |
| -4.8                 | 9.4          |
| "                    | 7.3          |
| -4.7                 | 5.0          |
| "                    | 4.4          |
| "                    | 3.9          |
| "                    | 4.0          |
| "                    | 4.3          |
| "                    | 3.7          |
| "                    | 4.0          |
| "                    | 5.0          |
| -4.6                 | 7.5          |
| "                    | 8.0          |
| "                    | 10.7         |
| "                    | 10.9         |
| -4.5                 | 11.1         |
| "                    | 10.7         |
| "                    | 10.5         |
| -4.4                 | 8.5          |
| "                    | 6.8          |
| "                    | 5.5          |
| -4.3                 | 3.9          |
| "                    | 2.1          |
| -4.2                 | 1.0          |
| "                    | 1.1          |
| "                    | 1.0          |
| -4.1                 | 2.3          |
| "                    | 1.1          |
| -4.0                 | 4.6          |

| Mean<br>solar<br>hour. | 5th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 6th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 7th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 8th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 9th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 10th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 11th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 12th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 13th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. | 14th.<br>to<br>level. | Ref.<br>obs.<br>to<br>level. |
|------------------------|----------------------|------------------------------|----------------------|------------------------------|----------------------|------------------------------|----------------------|------------------------------|----------------------|------------------------------|-----------------------|------------------------------|-----------------------|------------------------------|-----------------------|------------------------------|-----------------------|------------------------------|-----------------------|------------------------------|
| 1                      | 10.5                 | -3.8                         | 6.7                  | 10.7                         | -3.5                 | 7.2                          | 9.7                  | -4.1                         | 5.8                  | 9.6                          | -4.7                  | 4.9                          | 15.1                  | -6.9                         | 8.2                   | 17.6                         | -6.4                  | 11.2                         |                       |                              |
| 2                      | 11.8                 | "                            | 8.0                  | 12.1                         | "                    | 8.6                          | 11.0                 | "                            | 6.9                  | 8.9                          | -4.8                  | 4.1                          | 13.2                  | -7.0                         | 6.2                   | 15.7                         | -6.7                  | 9.0                          |                       |                              |
| 3                      | 12.7                 | -3.7                         | 9.0                  | 13.2                         | -3.6                 | 9.6                          | 12.1                 | "                            | 8.0                  | 8.9                          | -4.9                  | 4.0                          | 12.5                  | "                            | 5.5                   | 15.2                         | -6.9                  | 8.3                          |                       |                              |
| 4                      | 12.8                 | "                            | 9.1                  | "                            | "                    | 10.4                         | 12.8                 | "                            | 8.7                  | 9.0                          | -5.0                  | 4.0                          | 12.4                  | "                            | 5.4                   | 14.0                         | -7.1                  | 6.9                          |                       |                              |
| 5                      | 11.9                 | -3.6                         | 9.2                  | 14.1                         | "                    | 10.5                         | 12.9                 | "                            | 8.7                  | 9.0                          | -5.1                  | 3.9                          | 12.4                  | "                            | 5.4                   | 11.5                         | -7.3                  | 4.2                          |                       |                              |
| 6                      | 11.7                 | -3.5                         | 8.3                  | 14.1                         | -3.7                 | 10.4                         | 12.9                 | "                            | 8.8                  | 9.0                          | -5.2                  | 4.1                          | 12.4                  | "                            | 5.4                   | 10.2                         | -7.5                  | 2.7                          |                       |                              |
| 7                      | 11.2                 | "                            | 7.7                  | 14.0                         | "                    | 10.3                         | 12.9                 | "                            | 8.7                  | 10.0                         | -5.3                  | 4.7                          | 12.4                  | "                            | 5.5                   | 10.0                         | -7.7                  | 2.3                          |                       |                              |
| 8                      | 10.9                 | -3.4                         | 7.5                  | 13.9                         | "                    | 10.2                         | 12.9                 | -4.2                         | 8.7                  | 11.3                         | -5.4                  | 5.9                          | 12.8                  | "                            | 5.8                   | 10.7                         | -7.9                  | 2.8                          |                       |                              |
| 9                      | 9.7                  | "                            | 6.3                  | 12.9                         | -3.8                 | 9.1                          | 12.9                 | "                            | 8.7                  | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |
| 10                     | 8.7                  | -3.3                         | 5.4                  | 12.2                         | "                    | 8.4                          | 12.9                 | "                            | 8.7                  | 13.1                         | -5.5                  | 7.6                          | 14.2                  | "                            | 7.2                   | 12.4                         | -8.1                  | 4.3                          |                       |                              |
| 11                     | 7.4                  | "                            | 4.1                  | "                            | "                    | 7.3                          | 12.7                 | "                            | 8.7                  | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |
| 12                     | 6.3                  | -3.2                         | 3.1                  | 10.1                         | -3.0                 | 6.2                          | 12.1                 | "                            | 7.9                  | 15.2                         | -5.6                  | 9.6                          | 16.0                  | "                            | 9.0                   | 17.0                         | -8.3                  | 8.7                          |                       |                              |
| 13                     | 6.6                  | "                            | 3.4                  | 10.0                         | "                    | 6.1                          | 12.1                 | "                            | 15.5                 | -5.6                         | 9.9                   | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |
| 14                     | 6.7                  | -3.1                         | 3.5                  | 10.9                         | "                    | 6.0                          | 10.5                 | "                            | 15.5                 | -5.7                         | 9.8                   | 17.2                         | "                     | 10.2                         | 19.2                  | -8.5                         | 10.7                  |                              |                       |                              |
| 15                     | 6.7                  | "                            | 3.6                  | 10.9                         | "                    | 6.1                          | 10.5                 | "                            | 15.5                 | -5.7                         | 9.8                   | 17.2                         | "                     | 10.6                         | "                     | "                            | "                     | "                            | "                     | "                            |
| 16                     | 7.3                  | "                            | 4.2                  | 10.0                         | "                    | 6.1                          | 10.0                 | "                            | 5.8                  | 15.3                         | -5.8                  | 9.5                          | 17.6                  | "                            | 10.7                  | 19.7                         | -8.7                  | 12.0                         |                       |                              |
| 17                     | 9.5                  | -3.0                         | 6.5                  | 10.4                         | "                    | 6.5                          | 10.2                 | "                            | 6.0                  | "                            | "                     | "                            | "                     | "                            | 21.5                  | -8.8                         | 12.7                  |                              |                       |                              |
| 18                     | "                    | "                            | "                    | 10.4                         | "                    | 6.5                          | 10.2                 | "                            | 4.3                  | 5.9                          | -5.9                  | 9.1                          | ---                   | "                            | 18.0                  | -8.9                         | 9.1                   |                              |                       |                              |
| 19                     | 10.5                 | "                            | 7.5                  | 11.3                         | "                    | 7.3                          | 10.5                 | "                            | 6.2                  | 14.0                         | -6.0                  | 8.0                          | "                     | "                            | 18.3                  | -9.0                         | 9.3                   |                              |                       |                              |
| 20                     | 11.8                 | -3.1                         | 8.7                  | 12.0                         | "                    | 8.0                          | "                    | "                            | 11.9                 | -6.1                         | 5.8                   | "                            | "                     | "                            | 17.3                  | -9.1                         | 8.2                   |                              |                       |                              |
| 21                     | 12.3                 | "                            | 9.2                  | "                            | "                    | "                            | "                    | "                            | "                    | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |
| 22                     | 13.2                 | "                            | 10.1                 | 12.6                         | "                    | 8.6                          | "                    | "                            | 11.4                 | -6.2                         | 5.3                   | "                            | "                     | 16.0                         | -9.2                  | 6.8                          |                       |                              |                       |                              |
| 23                     | 13.2                 | "                            | 10.1                 | "                            | "                    | "                            | "                    | "                            | 11.4                 | -6.3                         | 5.2                   | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |
| 24                     | 13.2                 | -3.2                         | 10.0                 | 12.9                         | "                    | 8.9                          | "                    | "                            | 11.3                 | -6.3                         | 5.0                   | "                            | "                     | 13.7                         | "                     | 4.6                          |                       |                              |                       |                              |
| 25                     | 12.7                 | "                            | 9.5                  | "                            | "                    | "                            | "                    | "                            | 11.3                 | -6.3                         | 5.0                   | "                            | "                     | "                            | "                     | "                            | "                     | "                            | "                     | "                            |

March 6. No sounding.

March 8. No sounding.

3. *Formal language*  $L$  is a subset of  $\Sigma^*$ .

few observations taken.

derived from unpro-

derived from curves,

March 12. No sounding and but a few observations taken.

" 13. But few observations taken.

The corrections after March 7 are derived from curves.

## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## March, 1854.

|        | Mean<br>solar<br>hour. | 16th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 17th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 18th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 19th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 20th.<br>Red.<br>to<br>level. | Ref.<br>obs. | 21st.<br>Red.<br>to<br>level. | Ref.<br>obs. |       |      |
|--------|------------------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------------------------------|--------------|-------|------|
| 1      | 20.5                   | -10.0                         | 10.5         | 21.4                          | -9.6         | 11.8                          | 19.5         | -8.8                          | 10.7         | 21.4                          | -10.3        | 11.1                          | 19.8         | -11.0 | 8.8  |
| 2      | 20.5                   | "                             | 10.5         | 21.6                          | "            | 12.0                          | 20.3         | "                             | 11.5         | 22.2                          | -10.4        | 11.8                          | 21.3         | "     | 10.3 |
| 3      | 17.5                   | "                             | 7.5          | 19.8                          | -9.5         | 10.3                          | 19.5         | "                             | 10.7         | 22.7                          | -10.5        | 12.2                          | 21.7         | "     | 10.7 |
| 4      | 15.4                   | "                             | 5.4          | 17.5                          | "            | 8.0                           | 17.7         | -8.7                          | 9.0          | 22.2                          | -10.6        | 11.6                          | 22.4         | "     | 11.4 |
| 5      | 15.1                   | -10.1                         | 5.0          | 16.7                          | -9.4         | 7.3                           | 15.9         | "                             | 7.2          | 19.2                          | "            | 8.6                           | 22.4         | "     | 12.4 |
| 6      | 14.8                   | "                             | 4.7          | 14.8                          | "            | 5.4                           | 12.4         | "                             | 3.7          | 17.0                          | -10.7        | 6.3                           | 19.3         | "     | 8.3  |
| 7      | 14.3                   | "                             | 4.2          | 12.7                          | "            | 3.3                           | 11.2         | "                             | 2.5          | 15.0                          | "            | 4.3                           | 19.0         | "     | 8.0  |
| 8      | 13.9                   | "                             | 3.8          | 10.3                          | "            | 0.9                           | 10.7         | "                             | 2.0          | 13.4                          | "            | 3.4                           | 14.1         | "     | 9.5  |
| 9      | 15.6                   | "                             | 5.5          | 11.2                          | "            | 1.9                           | 10.3         | "                             | 1.8          | 14.7                          | -10.8        | 3.9                           | 13.2         | -4.3  | 8.9  |
| 10     | 16.5                   | "                             | 6.4          | 16.0                          | "            | 6.7                           | 10.3         | "                             | 1.6          | 16.2                          | "            | 5.4                           | 12.6         | -4.4  | 8.2  |
| 11     | 18.3                   | "                             | 8.2          | 19.6                          | -9.2         | 10.4                          | 13.3         | "                             | 4.6          | 17.2                          | "            | 6.4                           | 11.0         | -4.7  | 6.3  |
| Noon   | 18.3                   | -10.2                         | 8.1          | 17.0                          | "            | 14.6                          | -8.6         | 6.0                           | 19.3         | "                             | 8.5          | 11.2                          | -4.8         | 6.4   |      |
| 1      | 18.4                   | "                             | 8.2          | 19.6                          | -9.2         | 10.4                          | 16.9         | "                             | 8.3          | 20.3                          | "            | 9.5                           | 11.1         | -5.0  | 6.1  |
| 2      | 18.5                   | "                             | 8.3          | 19.5                          | "            | 10.3                          | 18.2         | -8.7                          | 9.5          | 21.5                          | "            | 10.7                          | 11.1         | "     | 6.1  |
| 3      | 15.0                   | -10.1                         | 4.9          | 18.6                          | -9.1         | 9.5                           | 18.1         | "                             | 9.4          | 21.6                          | -10.9        | 10.7                          | 10.4         | -5.1  | 5.3  |
| 4      | 13.5                   | -10.0                         | 3.5          | 17.2                          | "            | 8.1                           | 16.0         | -8.8                          | 7.2          | 21.4                          | "            | 10.5                          | 11.1         | -5.2  | 5.9  |
| 5      | 13.2                   | "                             | 3.2          | 16.8                          | "            | 7.7                           | 14.6         | -8.9                          | 5.7          | 20.2                          | "            | 9.3                           | 11.8         | -5.4  | 6.4  |
| 6      | 13.0                   | -9.9                          | 3.1          | 15.7                          | -9.0         | 6.7                           | 14.1         | -9.0                          | 5.1          | 17.2                          | "            | 6.3                           | 12.2         | -5.5  | 6.7  |
| 7      | 13.0                   | "                             | 3.1          | 14.3                          | "            | 5.3                           | 13.1         | -9.1                          | 4.0          | 13.9                          | "            | 3.0                           | 13.4         | -5.6  | 7.8  |
| 8      | 13.0                   | "                             | 3.1          | 12.1                          | "            | 3.1                           | 12.4         | -9.3                          | 3.1          | 13.5                          | "            | 2.6                           | 13.9         | -5.7  | 8.2  |
| 9      | 13.3                   | "                             | 3.4          | 10.2                          | "            | 1.2                           | 12.5         | -9.4                          | 3.1          | 13.5                          | "            | 2.6                           | 14.2         | -5.8  | 8.4  |
| 10     | 14.8                   | -9.8                          | 5.0          | 10.4                          | "            | 1.4                           | 13.0         | -9.6                          | 3.4          | 13.5                          | "            | 2.6                           | 14.3         | "     | 8.5  |
| 11     | 15.8                   | "                             | 6.0          | 13.2                          | -8.9         | 4.3                           | 14.2         | -9.8                          | 4.4          | 14.0                          | "            | 3.1                           | 14.0         | "     | 8.2  |
| 12     | 18.3                   | "                             | 8.5          | 13.6                          | "            | 4.7                           | 17.2         | -10.0                         | 7.2          | 18.4                          | "            | 7.5                           | 13.8         | -5.9  | 7.9  |
| Midn't | 20.0                   | -9.7                          | 10.3         | 13.9                          | "            | 5.0                           | 19.2         | -10.2                         | 9.0          | 20.9                          | -11.0        | 9.9                           | 12.2         | "     | 6.3  |
|        |                        |                               |              |                               |              |                               |              |                               |              |                               |              |                               | 12.0         | -6.0  | 6.0  |

|                            | Fath. | Feet. | Inch. |                            |
|----------------------------|-------|-------|-------|----------------------------|
| March 16. Sounding at noon | 8     | —     | —     | } Corrections from curves. |
| " 17. "                    | 7     | 5     | 6     |                            |
| " 18. "                    | 7     | 3     | 0     |                            |
| " 19. No sounding.         |       |       |       |                            |
| " 20. " "                  |       |       |       |                            |
| " 21. Sounding at noon     | 6     | 1     | 0     |                            |
| " 22. " "                  | 6     | 0     | 0     |                            |
| " 23. No sounding.         |       |       |       |                            |

# RECORD AND REDUCTION OF THE TIDES.

25

## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### March, 1854.

| Mean solar hour. | 24th.                | Red. to level.     | Ref. obs.   | 25th. | Red. to level. | Ref. obs. | 26th. | Red. to level. | Ref. obs. | 27th. | Red. to level. | Ref. obs. | 28th. | Red. to level. | Ref. obs. | 29th. | Red. to level. | Ref. obs. |
|------------------|----------------------|--------------------|-------------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|
| 1                | 11.3<br>10.9         | -6.0<br>4.8        | 5.3<br>5.5  | 8.5   | -0.1           | 8.4       | 9.9   | -2.9           | 7.0       | 10.2  | -1.1           | 9.1       | 15.0  | -4.7           | 10.3      | 15.5  | -3.5           | 12.0      |
| 2                | 10.9<br>10.9         | -6.1<br>4.8        | 5.5<br>5.5  | 8.5   | -0.2<br>5.3    | 8.3       | 8.3   | -3.0           | 5.3       | 8.2   | -1.3           | 6.9       | 12.4  | -4.9           | 7.5       | 13.3  | -3.2           | 10.1      |
| 3                | 11.2                 | -6.2               | 5.0         | 5.5   | -0.3           | 5.2       | 7.5   | -3.2           | 4.3       | 6.0   | -1.4           | 4.0       | 9.7   | -5.1           | 4.6       | 11.3  | -3.1           | 8.2       |
| 4                | 12.1                 | "                  | 5.9         | 5.5   | -0.4           | 5.1       | 7.3   | -3.4           | 3.9       | 3.9   | -1.5           | 2.6       | 9.0   | -5.2           | 3.8       | 9.0   | -3.0           | 6.0       |
| 5                | 12.9                 | -6.3               | 6.6         | 5.7   | -0.5           | 5.2       | 7.6   | -3.6           | 4.0       | 3.9   | -1.7           | 2.2       | 8.0   | -5.3           | 2.7       | 7.5   | "              | 4.5       |
| 6                | 13.8                 | "                  | 7.5         | 8.2   | -0.7           | 7.5       | 9.2   | -3.8           | 5.4       | 4.5   | -1.9           | 2.6       | 7.5   | -5.5           | 2.0       | 6.5   | "              | 3.5       |
| 7                | 15.0                 | -6.4               | 8.6         | 9.2   | -0.8           | 8.4       | 11.8  | -4.0           | 7.8       | 5.3   | -2.0           | 3.3       | 8.2   | -5.6           | 2.6       | 6.5   | "              | 3.5       |
| 8                | 16.7<br>16.0<br>16.4 | -6.5<br>8.0<br>9.9 | 10.2<br>9.9 | 9.9   | -1.0           | 8.9       | 13.5  | -4.2           | 9.3       | 8.0   | -2.1           | 5.9       | 11.2  | -5.8           | 5.4       | 8.6   | "              | 5.6       |
| 9                | 16.0                 | -6.6               | 9.4         | 11.2  | -1.1           | 10.1      | 16.0  | -4.4           | 11.6      | 12.1  | -2.2           | 9.9       | 16.4  | "              | 10.6      | 12.8  | "              | 9.8       |
| 10               | 15.5                 | -6.7               | 8.8         | 11.5  | -1.2           | 10.3      | 16.2  | -4.5           | 11.7      | 13.7  | -2.4           | 11.3      | 16.9  | "              | 11.1      | 14.9  | "              | 11.9      |
| 11               | 15.0                 | -6.8               | 8.2         | 11.5  | -1.3           | 10.2      | 15.5  | -4.7           | 11.5      | 14.0  | -2.5           | 11.5      | 17.2  | "              | 11.4      | "     | "              | "         |
| Noon             | 8.7                  | -6.8               | 8.2         | 11.5  | -1.4           | 10.1      | 14.0  | -5.2           | 8.8       | 14.0  | -2.1           | 11.9      | 17.7  | "              | 11.9      | 16.5  | "              | 13.5      |
|                  | 8.7                  | -6.8               | 8.2         | 11.5  | -1.4           | 10.1      | 14.0  | -5.2           | 8.8       | 14.0  | -2.1           | 11.9      | 17.7  | "              | 11.9      | 16.5  | "              | 13.5      |
|                  | 8.7                  | -6.8               | 8.2         | 11.5  | -1.4           | 10.1      | 14.0  | -5.2           | 8.8       | 14.0  | -2.1           | 11.9      | 17.7  | "              | 11.9      | 16.5  | "              | 13.5      |
|                  | 8.7                  | -6.8               | 8.2         | 11.5  | -1.4           | 10.1      | 14.0  | -5.2           | 8.8       | 14.0  | -2.1           | 11.9      | 17.7  | "              | 11.9      | 16.5  | "              | 13.5      |
| 1                | 7.7                  | -6.7               | 8.7         | 8.7   | -1.6           | 7.1       | 10.3  | -4.8           | 12.6      | -2.9  | 9.7            | 16.3      | "     | 10.4           | 17.5      | 17.5  | "              | 14.5      |
| 2                | 5.8<br>5.6           | -6.3<br>5.3        | 5.5<br>5.3  | 7.7   | -1.7           | 6.0       | 8.7   | "              | 9.4       | -3.1  | 6.3            | 16.3      | -5.8  | 10.5           | 16.3      | 16.3  | "              | 13.9      |
| 3                | 5.6<br>5.6           | -6.1<br>5.5        | 6.8<br>6.6  | 8.8   | -1.9           | 4.7       | 6.2   | "              | 6.6       | -3.2  | 3.4            | 16.6      | -5.6  | 11.0           | 11.0      | "     | 8.0            |           |
| 4                | 5.6                  | -6.0               | 5.5         | 6.3   | -2.0           | 4.3       | 3.4   | 3.4            | 3.4       | 4.9   | "              | 1.5       | 11.5  | -5.1           | 6.4       | 5.0   | "              | 4.0       |
| 5                | 6.0                  | "                  | 6.0         | 6.6   | -2.1           | 4.5       | 5.5   | -0.1           | 3.4       | 5.1   | -3.5           | 1.6       | 11.5  | -5.1           | 6.4       | 5.0   | "              | 2.7       |
| 6                | 6.8                  | "                  | 7.3         | 7.3   | -2.2           | 5.2       | 3.9   | -0.3           | 3.6       | 5.2   | -3.7           | 1.5       | 10.2  | -4.9           | 5.3       | 2.9   | "              | -0.1      |
| 7                | 7.6                  | "                  | 6.8         | 7.8   | -2.2           | 5.6       | 3.9   | -0.3           | 3.6       | 5.2   | -3.7           | 1.5       | 10.2  | -4.9           | 5.3       | 2.9   | "              | -0.1      |
| 8                | 7.7                  | "                  | 7.6         | 9.3   | -2.3           | 7.0       | 4.6   | -0.4           | 4.2       | 6.9   | -3.9           | 3.0       | 3.8   | -4.7           | -0.9      | 3.2   | "              | 0.2       |
| 9                | 8.3                  | "                  | 7.7         | 10.9  | -2.4           | 8.5       | 6.9   | -0.5           | 6.4       | 8.6   | -4.1           | 4.5       | 6.2   | -4.6           | 1.6       | 5.2   | "              | 2.2       |
| 10               | 9.1                  | "                  | 8.3         | 11.4  | -2.5           | 8.9       | 9.9   | -0.6           | 9.3       | 12.3  | -4.2           | 8.1       | 11.6  | -4.4           | 7.2       | 7.2   | "              | 4.2       |
| 11               | 9.2                  | "                  | 9.1         | 12.2  | -2.6           | 9.6       | 11.2  | -0.8           | 10.4      | 13.9  | -4.3           | 9.6       | 12.6  | -4.2           | 8.4       | 10.5  | "              | 7.7       |
| 12               | 9.2                  | "                  | 9.2         | 12.0  | "              | 9.4       | 14.4  | "              | 10.1      | 14.4  | "              | 10.1      | 14.6  | -4.0           | 10.6      | 13.7  | "              | 10.5      |
| Midn't           | 8.7                  | "                  | 8.7         | 12.3  | "              | 12.3      | 11.9  | -0.9           | 11.0      | 14.8  | -4.4           | 10.4      | 14.6  | -4.0           | 10.6      | 13.7  | "              | 10.5      |
|                  | 8.4                  | "                  | 8.4         | 11.5  | -2.8           | 8.7       | 11.4  | -1.0           | 10.4      | 15.2  | -4.5           | 10.7      | 15.5  | -3.7           | 11.8      | 15.5  | "              | 12.5      |



## SERIES II.—TIDAL OBSERVATIONS FROM JANUARY 28 TO APRIL 7, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| March, 1854.    |      |                |           |      |                |           |      |                |           | April, 1854. |                |           |      |                |           |      |                |           |  |
|-----------------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|--------------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|--|
| Mean solar hour | 30th | Red. to level. | Ref. obs. | 31st | Red. to level. | Ref. obs. | 1st  | Red. to level. | Ref. obs. | 2nd          | Red. to level. | Ref. obs. | 3rd  | Red. to level. | Ref. obs. | 4th  | Red. to level. | Ref. obs. |  |
| 1               | 15.3 | -3.0           | 12.3      |      |                |           |      |                |           | 8.3          | -3.0           | 5.3       | 7.5  | -1.7           | 5.8       | 7.0  | -1.5           | 5.5       |  |
|                 | 15.3 | "              | 12.3      | 13.8 | -3.0           | 10.8      | ...  | ...            | ...       | 9.6          | "              | 6.6       | 7.8  | "              | 6.1       | 7.5  | "              | 6.0       |  |
| 2               | 15.4 | "              | 12.4      | 14.5 | "              | 11.5      | ...  | ...            | ...       | 10.5         | -2.9           | 7.6       | 8.4  | -1.6           | 6.8       | 7.5  | "              | 6.0       |  |
|                 | 15.3 | "              | 12.3      | 13.2 | "              | 10.3      | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 3               | 14.6 | "              | 11.6      | 12.0 | "              | 9.0       | ...  | ...            | ...       | 11.2         | -2.8           | 8.4       | 9.6  | "              | 8.0       | 7.5  | "              | 6.0       |  |
| 4               | 13.6 | "              | 10.6      | 9.7  | "              | 6.7       | ...  | ...            | ...       | 11.8         | "              | 9.0       | 10.0 | "              | 8.4       | 8.0  | "              | 6.5       |  |
| 5               | 11.8 | "              | 8.8       | 7.0  | "              | 4.0       | ...  | ...            | ...       | 12.2         | -2.7           | 9.5       | 10.4 | "              | 8.8       | 8.6  | "              | 7.1       |  |
| 6               | 9.4  | "              | 6.4       | 5.6  | "              | 2.6       | ...  | ...            | ...       | 12.4         | "              | 9.7       | 10.4 | "              | 8.8       | 9.8  | "              | 8.3       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | 12.4         | "              | 9.7       | 10.4 | "              | 8.8       | 9.2  | "              | 8.4       |  |
| 7               | 6.9  | "              | 3.9       | 5.0  | "              | 2.0       | ...  | ...            | ...       | 11.2         | -2.6           | 8.6       | 10.4 | "              | 8.8       | 10.0 | "              | 8.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 8               | 6.3  | "              | 3.3       | 4.5  | "              | 1.5       | ...  | ...            | ...       | 9.2          | -2.5           | 6.7       | 10.4 | "              | 8.8       | 10.0 | "              | 8.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 9               | 7.2  | "              | 4.2       | 6.0  | "              | 3.0       | ...  | ...            | ...       | 8.1          | "              | 5.0       | 10.0 | "              | 8.4       | 10.0 | "              | 8.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 10              | 10.1 | "              | 7.1       | 8.0  | "              | 5.0       | ...  | ...            | ...       | 7.4          | -2.4           | 5.0       | 9.1  | "              | 7.5       | 9.5  | "              | 8.0       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | 7.4          | "              | 5.0       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 11              | 12.9 | "              | 9.9       | 10.1 | "              | 7.1       | ...  | ...            | ...       | 7.4          | "              | 5.0       | 8.5  | "              | 6.9       | 8.8  | "              | 7.3       |  |
|                 | 15.2 | "              | 12.2      | ...  | ...            | ...       | ...  | ...            | ...       | 7.4          | "              | 5.0       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| Noon            | 16.5 | "              | 13.5      | 11.9 | "              | 8.9       | 9.0  | -4.0           | 5.0       | 8.0          | -2.3           | 5.7       | 8.0  | -1.5           | 6.5       | 8.5  | -1.5           | 7.0       |  |
|                 | 16.1 | "              | 13.1      | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 1               | 15.3 | "              | 12.3      | 14.7 | "              | 11.7      | 9.7  | "              | 5.7       | 8.6          | "              | 6.3       | 7.5  | "              | 6.0       | 7.0  | "              | 5.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 2               | 13.3 | "              | 10.3      | 15.8 | "              | 12.8      | 11.0 | -3.9           | 7.1       | 8.9          | -2.2           | 6.7       | 7.5  | "              | 6.0       | 7.0  | "              | 5.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 3               | 12.3 | "              | 9.3       | 15.2 | "              | 12.2      | 11.3 | "              | 7.4       | 8.9          | -2.1           | 6.8       | 7.5  | "              | 6.0       | 7.0  | "              | 5.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | 12.3 | -3.8           | 8.5       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 4               | 8.1  | "              | 5.1       | 14.7 | "              | 11.7      | 13.1 | "              | 9.3       | 8.9          | "              | 6.8       | 7.5  | "              | 6.0       | 7.0  | "              | 5.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | 12.9 | -3.7           | 9.2       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 5               | 7.0  | "              | 4.0       | 12.9 | "              | 9.9       | 11.7 | "              | 8.0       | 8.6          | -2.0           | 6.6       | 7.9  | "              | 6.4       | 7.5  | "              | 6.0       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | 8.0          | "              | 6.9       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 6               | 5.5  | "              | 2.5       | 10.8 | "              | 7.8       | 9.9  | -3.6           | 6.3       | 8.9          | "              | 6.9       | 8.0  | "              | 6.5       | 8.1  | "              | 6.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | 8.7          | -1.9           | 6.8       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 7               | 4.4  | "              | 1.4       | 11.5 | "              | 8.5       | 9.0  | "              | 5.4       | 8.7          | "              | 6.8       | 8.0  | "              | 6.5       | 8.7  | "              | 7.2       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 8               | 4.3  | "              | 1.3       | 8.4  | -2.9           | 5.5       | 8.0  | -3.5           | 4.5       | 8.1          | "              | 6.2       | 8.0  | "              | 6.5       | 9.0  | "              | 7.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 9               | 6.8  | "              | 3.8       | 6.1  | -2.8           | 3.3       | 8.2  | "              | 4.4       | 8.0          | -1.8           | 6.2       | 8.2  | "              | 6.7       | 9.0  | "              | 7.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 10              | 10.3 | "              | 7.3       | 8.8  | -2.7           | 6.1       | 7.5  | -3.3           | 4.2       | 7.5          | "              | 5.7       | 7.8  | "              | 6.3       | 9.0  | "              | 7.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| 11              | 12.2 | "              | 9.2       | 11.4 | -2.6           | 8.8       | 7.5  | -3.2           | 4.3       | 7.5          | "              | 5.7       | 7.3  | "              | 5.8       | 9.0  | "              | 7.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |
| Midn.           | 13.1 | "              | 10.1      | 13.0 | -2.5           | 10.5      | 8.3  | -3.1           | 5.2       | 7.5          | -1.7           | 5.8       | 7.0  | "              | 5.5       | 9.0  | "              | 7.5       |  |
|                 | ...  | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       | ...          | ...            | ...       | ...  | ...            | ...       | ...  | ...            | ...       |  |

|                            |       |      |       |                                                                                                   |
|----------------------------|-------|------|-------|---------------------------------------------------------------------------------------------------|
|                            | Fath. | Fms. | Inch. |                                                                                                   |
| March 30, Sounding at noon | 7     | 4    | 6     | Correction by curves preferred.                                                                   |
| " 31, No sounding,         |       |      |       |                                                                                                   |
| April 1, " "               |       |      |       |                                                                                                   |
| " 4, Sounding at noon      | 6     | 3    | 0     | Corrections derived from curves, readings (heights) not reliable, see preceding note of April 14. |
| " 5, " "                   | 6     | 2    | 0     |                                                                                                   |
| " 6, " "                   | 6     | 2    | 0     |                                                                                                   |
| " 7, " "                   | 6     | 2    | 0     |                                                                                                   |

# RECORD AND REDUCTION OF THE TIDES.

27

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### April, 1854.

| Mean solar hour. | 20th.      | Red. to level. | Ref. obs. | 21st. | Red. to level. | Ref. obs. | 22d. | Red. to level. | Ref. obs. | 23d. | Red. to level. | Ref. obs. | 24th. | Red. to level. | Ref. obs. | 25th. | Red. to level. | Ref. obs. |
|------------------|------------|----------------|-----------|-------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|-------|----------------|-----------|-------|----------------|-----------|
| 1                | Irregular. |                |           | 6.7   | -2.2           | 4.5       | 7.8  | -3.5           | 4.3       | 10.0 | -4.2           | 5.8       | 9.4   | -4.0           | 5.4       | 11.1  | -3.5           | 7.6       |
| 2                |            |                |           | 7.3   | "              | 5.1       | 7.5  | "              | 4.0       | 4.0  | "              | 5.7       | 7.5   | "              | 3.5       | 8.8   | "              | 5.3       |
| 3                |            |                |           | 7.0   | -2.3           | 5.4       | 7.7  | -3.6           | 4.1       | 9.9  | "              | 8.5       | "     | 4.3            | 2.7       | 7.5   | "              | 4.0       |
| 4                |            |                |           | 9.0   | -2.4           | 6.6       | 7.9  | "              | 4.3       | 8.3  | "              | 4.1       | 6.7   | "              | 4.5       | 6.5   | -3.9           | 2.6       |
| 5                |            |                |           | 10.2  | "              | 7.8       | 8.0  | -3.7           | 5.2       | 8.7  | "              | 4.5       | 6.5   | -3.9           | 2.6       | 6.4   | -3.4           | 3.0       |
| 6                |            |                |           | 11.4  | -2.5           | 8.9       | 9.7  | "              | 6.0       | 10.2 | "              | 6.0       | 7.1   | "              | 3.2       | 5.0   | "              | 2.4       |
| 7                |            |                |           | 12.1  | "              | 9.6       | 12.2 | -3.8           | 8.4       | 11.8 | "              | 7.6       | 8.8   | "              | 4.9       | 7.0   | "              | 2.6       |
| 8                |            |                |           | 12.5  | -2.6           | 9.9       | 13.3 | "              | 9.5       | 13.2 | "              | 9.0       | 10.5  | "              | 6.6       | 8.5   | "              | 5.1       |
| 9                |            |                |           | 12.5  | -2.7           | 9.8       | 14.1 | -3.9           | 10.1      | 14.9 | "              | 10.7      | 12.9  | "              | 9.0       | 10.0  | -3.3           | 7.6       |
| 10               |            |                |           | 11.3  | -1.0           | 10.3      | 11.0 | -2.8           | 8.2       | 10.7 | "              | 9.8       | 13.0  | "              | 11.1      | 13.4  | "              | 10.1      |
| 11               |            |                |           | 8.3   | -1.1           | 7.2       | 9.0  | "              | 7.1       | 12.3 | "              | 8.4       | 78.1  | "              | 11.0      | 15.5  | "              | 11.2      |
| Noon             |            |                |           | 6.7   | -1.2           | 5.5       | 8.5  | -2.9           | 5.6       | 11.3 | "              | 7.4       | 10.7  | "              | 10.7      | 14.1  | "              | 10.8      |
| 1                |            |                |           | 6.4   | "              | 5.2       | 7.9  | -3.0           | 4.9       | 10.7 | -4.0           | 6.7       | 11.5  | -4.3           | 7.2       | 12.9  | -3.8           | 9.1       |
| 2                |            |                |           | 6.4   | "              | 5.1       | 7.4  | "              | 4.4       | 8.7  | "              | 4.7       | 9.5   | "              | 5.2       | 10.6  | "              | 6.8       |
| 3                |            |                |           | 6.7   | "              | 5.4       | 7.0  | "              | 4.0       | 8.0  | "              | 4.0       | 8.3   | "              | 4.0       | 9.0   | "              | 5.2       |
| 4                |            |                |           | 7.1   | -1.4           | 5.7       | 7.0  | -3.1           | 3.9       | 8.3  | "              | 4.3       | 8.3   | "              | 4.0       | 9.0   | "              | 5.1       |
| 5                |            |                |           | 7.9   | "              | 6.5       | 8.0  | "              | 4.9       | 8.0  | "              | 4.0       | 7.2   | -4.2           | 3.0       | 7.4   | "              | 3.6       |
| 6                |            |                |           | 9.0   | -1.5           | 7.5       | 8.8  | -3.2           | 5.0       | 8.0  | "              | 4.0       | 6.6   | "              | 2.4       | 6.1   | -3.7           | 2.4       |
| 7                |            |                |           | 9.5   | "              | 8.0       | 8.5  | "              | 5.3       | 9.0  | -4.1           | 4.9       | 6.5   | -4.1           | 2.4       | 5.7   | "              | 2.0       |
| 8                |            |                |           | 9.7   | "              | 8.2       | 9.2  | -3.3           | 5.9       | 10.8 | "              | 6.7       | 7.5   | "              | 3.4       | 8.1   | "              | 4.4       |
| 9                |            |                |           | 9.7   | "              | 8.1       | 10.1 | "              | 6.8       | 11.5 | "              | 7.4       | 9.3   | "              | 5.2       | 9.0   | "              | 5.3       |
| 10               |            |                |           | 9.5   | "              | 7.9       | 10.5 | "              | 7.2       | 12.5 | "              | 8.4       | 10.8  | "              | 6.7       | 10.4  | -3.6           | 6.8       |
| 11               |            |                |           | 8.8   | -1.7           | 7.1       | 10.5 | "              | 7.2       | 12.5 | "              | 8.4       | 10.8  | "              | 6.7       | 10.4  | -3.6           | 6.8       |
| Midn't           |            |                |           | 7.0   | -1.8           | 6.1       | 10.5 | -3.4           | 7.1       | 13.0 | "              | 8.9       | 12.0  | "              | 7.9       | 13.5  | "              | 9.9       |
|                  |            |                |           | 7.0   | -1.9           | 5.1       | 9.1  | "              | 6.6       | 13.9 | "              | 9.8       | 12.8  | "              | 8.7       | 13.5  | "              | 9.9       |
|                  |            |                |           | 6.9   | -2.0           | 4.9       | 8.4  | "              | 5.0       | 12.0 | -4.2           | 7.8       | 13.0  | "              | 9.0       | 12.0  | "              | 8.4       |
|                  |            |                |           | 6.9   | -2.1           | 4.8       | 7.9  | -3.5           | 4.4       | 11.3 | "              | 7.1       | 9.0   | "              | 5.0       | 11.5  | -3.5           | 8.0       |

#### April 20. No sounding.

|                        | Fath. | Feet. | Inch. |
|------------------------|-------|-------|-------|
| " 21. Sounding at noon | 6     | 1     | 0     |
| " 22. " "              | 6     | 3     | 0     |
| " 23. " "              | 6     | 3     | 6     |
| " 24. " "              | 6     | 4     | 5     |
| " 25. " "              | 7     | 0     | 6     |

The corrections were deduced from the curves

(heights) not

SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.  
Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| April, 1854.          |       |                      |              |       |                      |              |       |                      |              |       |                      |              |       | May, 1854.           |              |      |                      |              |
|-----------------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|-------|----------------------|--------------|------|----------------------|--------------|
| Mean<br>solar<br>hour | 26th. | Red.<br>to<br>level. | Ref.<br>obs. | 27th. | Red.<br>to<br>level. | Ref.<br>obs. | 28th. | Red.<br>to<br>level. | Ref.<br>obs. | 29th. | Red.<br>to<br>level. | Ref.<br>obs. | 30th. | Red.<br>to<br>level. | Ref.<br>obs. | 1st. | Red.<br>to<br>level. | Ref.<br>obs. |
| 1                     | 10.1  | -3.0                 | 7.1          | 11.4  | -3.0                 | 11.3         | 9.2   | -3.0                 | 6.2          | 16.4  | -3.4                 | 13.0         | 16.4  | -3.0                 | 12.8         | 16.2 | "                    | 12.3         |
| 2                     | 9.1   | "                    | 6.1          | 12.1  | "                    | 11.1         | 7.8   | "                    | 4.8          | 14.9  | "                    | 11.5         | 12.8  | "                    | 9.2          | 15.9 | -4.0                 | 11.6         |
| 3                     | 7.1   | "                    | 4.1          | 10.5  | "                    | 7.5          | 7.0   | "                    | 4.0          | 13.1  | "                    | 9.7          | 10.3  | "                    | 6.7          | 14.7 | "                    | 10.7         |
| 4                     | 5.6   | "                    | 2.6          | 8.3   | "                    | 5.3          | 6.0   | "                    | 3.0          | 11.7  | "                    | 8.3          | 7.6   | "                    | 4.0          | 13.4 | "                    | 9.4          |
| 5                     | 5.8   | "                    | 2.8          | 6.8   | "                    | 3.8          | 5.0   | "                    | 2.0          | 9.8   | "                    | 6.4          | 6.2   | "                    | 2.6          | 12.2 | "                    | 8.2          |
| 6                     | 6.3   | "                    | 3.3          | 6.8   | "                    | 3.8          | 5.0   | "                    | 2.0          | 9.8   | "                    | 6.4          | 6.2   | "                    | 2.6          | 12.2 | "                    | 8.2          |
| 7                     | 7.3   | "                    | 4.3          | 4.7   | "                    | 1.7          | 5.7   | "                    | 2.7          | 8.0   | "                    | 4.6          | 6.2   | "                    | 2.6          | 10.0 | "                    | 6.0          |
| 8                     | 8.5   | "                    | 5.5          | 4.0   | "                    | 1.0          | 6.0   | -3.1                 | 3.5          | 5.9   | "                    | 2.5          | 7.7   | "                    | 4.1          | 8.9  | "                    | 4.9          |
| 9                     | 9.4   | "                    | 6.4          | 8.7   | "                    | 5.7          | 6.5   | "                    | 4.4          | 6.2   | "                    | 2.8          | 9.1   | "                    | 5.5          | 8.2  | "                    | 4.2          |
| 10                    | 10.6  | "                    | 7.6          | 10.9  | "                    | 7.9          | 8.8   | "                    | 5.7          | 8.3   | "                    | 4.9          | 10.1  | "                    | 6.5          | 7.9  | "                    | 4.0          |
| 11                    | 11.4  | "                    | 8.4          | 12.7  | "                    | 9.7          | 10.3  | "                    | 7.2          | 10.9  | "                    | 7.5          | 11.2  | "                    | 7.6          | 9.7  | "                    | 4.4          |
| 12                    | 13.9  | "                    | 10.9         | 14.4  | "                    | 11.4         | 11.7  | "                    | 8.6          | 13.5  | "                    | 10.1         | 13.0  | "                    | 9.4          | 11.9 | "                    | 7.9          |
| 13                    | 14.4  | "                    | 11.4         | 14.5  | "                    | 11.5         | 14.6  | "                    | 11.2         | 14.6  | "                    | 11.2         | 14.7  | "                    | 11.0         | 13.1 | -4.1                 | 9.0          |
| 14                    | 15.0  | "                    | 12.0         | 15.2  | "                    | 12.1         | 13.7  | 3.2                  | 10.5         | 15.5  | -3.5                 | 12.0         | 14.7  | -3.7                 | 11.0         | 13.1 | -4.1                 | 9.0          |
| 15                    | 15.0  | "                    | 11.0         | 15.2  | "                    | 12.2         | 11.5  | "                    | 11.3         | 14.5  | "                    | 11.0         | 15.0  | "                    | 11.3         | 13.5 | "                    | 9.4          |
| 1                     | 13.1  | "                    | 10.1         | 15.0  | "                    | 12.0         | 14.8  | "                    | 11.6         | 13.2  | "                    | 9.7          | 14.4  | "                    | 10.7         | 13.0 | "                    | 8.9          |
| 2                     | 10.7  | "                    | 7.7          | 12.4  | "                    | 9.4          | 14.1  | "                    | 11.1         | 10.9  | "                    | 7.4          | 12.6  | "                    | 8.9          | 11.3 | "                    | 7.2          |
| 3                     | 8.7   | "                    | 5.7          | 10.3  | "                    | 7.3          | 12.1  | "                    | 9.2          | 9.6   | "                    | 6.1          | 10.2  | "                    | 6.5          | 10.2 | -4.2                 | 6.0          |
| 4                     | 6.1   | "                    | 3.1          | 7.3   | "                    | 4.3          | 9.2   | "                    | 6.0          | 7.1   | "                    | 3.6          | 8.0   | "                    | 4.3          | 9.8  | "                    | 5.6          |
| 5                     | 4.1   | "                    | 1.1          | 6.2   | "                    | 3.2          | 6.0   | "                    | 2.8          | 5.3   | -3.5                 | 1.8          | 5.5   | -3.8                 | 1.7          | 9.1  | "                    | 4.9          |
| 6                     | 3.2   | "                    | 0.2          | 5.7   | "                    | 2.9          | 5.0   | "                    | 2.4          | 5.0   | "                    | 1.5          | 5.5   | "                    | 1.7          | 8.6  | "                    | 4.4          |
| 7                     | 3.1   | "                    | 0.1          | 5.7   | "                    | 2.7          | 5.5   | "                    | 2.3          | 5.1   | "                    | 1.6          | 6.2   | "                    | 2.4          | 8.0  | "                    | 3.8          |
| 8                     | 4.0   | "                    | 1.6          | 9.6   | "                    | 6.6          | 5.3   | -3.3                 | 2.0          | 7.1   | "                    | 3.6          | 7.6   | "                    | 3.8          | 8.0  | -4.3                 | 3.7          |
| 9                     | 7.2   | "                    | 4.2          | 10.8  | "                    | 7.8          | 7.8   | "                    | 4.5          | 8.6   | "                    | 5.1          | 8.5   | "                    | 4.7          | 8.8  | "                    | 4.5          |
| 10                    | 10.7  | "                    | 7.7          | 12.3  | "                    | 9.3          | 10.2  | "                    | 6.9          | 10.4  | "                    | 6.9          | 9.5   | "                    | 5.7          | 10.2 | "                    | 5.9          |
| 11                    | 12.8  | "                    | 9.3          | 14.0  | "                    | 11.0         | 12.8  | "                    | 9.5          | 13.4  | "                    | 9.9          | 11.3  | "                    | 7.5          | 11.3 | "                    | 7.0          |
| 12                    | 14.2  | "                    | 11.2         | 15.7  | "                    | 14.8         | "     | 11.5                 | 15.3         | "     | 11.8                 | 13.9         | -3.9  | 10.6                 | 12.7         | "    | 8.4                  |              |
| 13                    | 14.3  | "                    | 11.3         | 16.7  | "                    | 15.5         | -3.3  | 12.2                 | 16.4         | "     | 12.9                 | 15.4         | "     | 11.5                 | 14.1         | -4.4 | 9.7                  |              |

Fath Feet Inch  
 April 26. Sounding at noon 7 3 0 Corrections deduced from the curves.  
 " 27. " " 7 3 2 " " " "  
 " 28-30. No sounding.  
 May 1. Sounding at noon 7 4 0

## RECORD AND REDUCTION OF THE TIDES.

29

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## May, 1854.

|        | Mean solar hour. | 2d.  | Red. to level. | Ref. obs. | 3d.  | Red. to level. | Ref. obs. | 4th. | Red. to level. | Ref. obs. | 5th. | Red. to level. | Ref. obs. | 6th. | Red. to level. | Ref. obs. | 7th. | Red. to level. | Ref. obs. | 8th. | Red. to level. | Ref. obs. | 9th. | Red. to level. | Ref. obs. |
|--------|------------------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|------|----------------|-----------|
| 1      | 15.1             | -4.4 | 10.7           | 13.2      | "    | 8.5            | 13.6      | -5.2 | 8.4            | 10.2      | -4.2 | 6.0            | 10.5      | -4.8 | 5.7            | 10.2      | "    | 6.0            | 10.0      | "    | 5.2            | 10.7      | -5.5 | 5.2            | 10.7      |
| 2      | 16.7             | "    | 12.3           | 14.0      | "    | 9.3            | 14.0      | -5.3 | 8.7            | 10.8      | "    | 6.3            | 11.5      | "    | 6.7            | 10.8      | "    | 6.0            | 11.5      | -4.9 | 6.6            | 10.0      | -5.6 | 4.4            | 10.0      |
| 3      | 16.5             | "    | 12.1           | 14.2      | "    | 9.5            | 14.8      | -5.4 | 9.4            | 11.3      | "    | 7.1            | 11.8      | "    | 6.9            | 11.3      | "    | 6.0            | 10.5      | "    | 6.0            | 10.5      | "    | 4.9            | 10.5      |
| 4      | 14.2             | -4.5 | 9.7            | 14.3      | "    | 9.6            | 16.1      | -5.6 | 10.6           | 11.8      | "    | 7.6            | 12.4      | "    | 7.5            | 12.6      | -5.7 | 6.9            | 10.5      | "    | 7.5            | 12.6      | -5.7 | 6.9            | 10.5      |
| 5      | 12.5             | "    | 8.0            | 14.1      | "    | 9.4            | 16.2      | -5.8 | 10.4           | 12.4      | "    | 8.2            | 13.0      | "    | 8.1            | 14.3      | "    | 8.6            | 10.5      | "    | 8.1            | 14.3      | "    | 8.6            | 10.5      |
| 6      | 11.0             | "    | 6.5            | 13.1      | "    | 8.4            | 16.2      | -6.0 | 10.2           | 13.2      | -4.3 | 8.9            | 14.1      | "    | 5.0            | 9.1       | 15.6 | "              | 9.9       | 10.5 | "              | 9.1       | 15.6 | "              | 9.9       |
| 7      | 8.4              | "    | 3.9            | 12.0      | "    | 7.3            | 15.3      | -6.1 | 9.6            | 13.2      | "    | 8.9            | 16.2      | "    | 11.2           | 16.4      | -5.8 | 10.6           | 10.5      | "    | 11.2           | 16.4      | -5.8 | 10.6           | 10.5      |
| 8      | 6.7              | "    | 2.2            | 10.9      | "    | 6.2            | 15.4      | -6.1 | 9.6            | 13.0      | "    | 8.7            | 16.0      | "    | 11.0           | 17.2      | -5.0 | 11.3           | 10.5      | "    | 11.0           | 17.2      | -5.0 | 11.3           | 10.5      |
| 9      | 6.4              | -4.6 | 1.8            | 10.0      | "    | 5.3            | 15.4      | -6.1 | 9.6            | 12.2      | "    | 7.9            | 16.5      | -5.1 | 11.4           | 17.2      | -6.0 | 11.2           | 10.5      | "    | 11.4           | 17.2      | -6.0 | 11.2           | 10.5      |
| 10     | 7.4              | "    | 2.8            | 10.5      | "    | 5.8            | 15.4      | -6.1 | 9.6            | 11.0      | "    | 6.7            | 16.0      | "    | 10.9           | 16.0      | -6.1 | 9.9            | 10.5      | "    | 10.9           | 16.0      | -6.1 | 9.9            | 10.5      |
| 11     | 9.5              | "    | 4.9            | 11.0      | "    | 6.3            | 15.4      | -6.1 | 9.6            | 10.2      | "    | 5.9            | 15.1      | "    | 10.0           | 14.9      | -6.2 | 8.7            | 10.5      | "    | 10.0           | 14.9      | -6.2 | 8.7            | 10.5      |
| Noon   | 11.3             | -4.7 | 6.6            | 11.4      | 4.7  | 6.7            | 15.4      | -6.1 | 9.6            | 9.0       | -1.4 | 4.6            | 14.1      | -5.2 | 8.9            | 13.8      | -6.3 | 7.5            | 10.5      | "    | 8.9            | 13.8      | -6.3 | 7.5            | 10.5      |
| 1      | 13.1             | "    | 8.4            | 12.8      | "    | 8.1            | 15.4      | -6.1 | 9.6            | 8.1       | "    | 3.7            | 13.0      | "    | 7.8            | "         | "    | "              | 10.5      | "    | 7.8            | "         | "    | "              | "         |
| 2      | 14.9             | "    | 10.2           | 13.8      | "    | 9.1            | 15.4      | -6.1 | 9.6            | 8.0       | "    | 3.6            | 10.6      | "    | 5.7            | 11.2      | "    | 4.9            | 10.5      | "    | 5.7            | 11.2      | "    | 4.9            | 10.5      |
| 3      | 14.5             | "    | 9.8            | 13.8      | "    | 9.1            | 15.4      | -6.1 | 9.6            | 8.4       | "    | 4.0            | 9.0       | -5.3 | 3.7            | 10.0      | -6.2 | 3.8            | 10.5      | "    | 3.7            | 10.0      | -6.2 | 3.8            | 10.5      |
| 4      | 13.6             | "    | 8.9            | 13.8      | "    | 9.1            | 15.4      | -6.1 | 9.6            | 9.0       | -4.5 | 4.5            | 8.0       | "    | 2.7            | 8.0       | "    | 1.8            | 10.5      | "    | 2.7            | 8.0       | "    | 1.8            | 10.5      |
| 5      | 12.6             | "    | 7.9            | 12.7      | "    | 8.0            | 15.4      | -6.1 | 9.6            | 9.8       | "    | 5.3            | 9.0       | -5.4 | 3.6            | 8.9       | "    | 2.7            | 10.5      | "    | 3.6            | 8.9       | "    | 2.7            | 10.5      |
| 6      | 10.1             | "    | 5.1            | 12.1      | -4.8 | 7.3            | 15.4      | -6.1 | 9.6            | 10.3      | "    | 5.8            | 10.2      | "    | 4.8            | 11.2      | -6.1 | 5.1            | 10.5      | "    | 4.8            | 11.2      | -6.1 | 5.1            | 10.5      |
| 7      | 9.5              | "    | 4.8            | 11.8      | "    | 7.0            | 15.4      | -6.1 | 9.6            | 11.0      | -4.6 | 6.1            | 11.6      | "    | 6.2            | 13.0      | "    | 6.9            | 10.5      | "    | 6.2            | 13.0      | "    | 6.9            | 10.5      |
| 8      | 9.0              | "    | 4.3            | 11.6      | -4.9 | 6.7            | 15.4      | -6.1 | 9.6            | 11.3      | "    | 6.7            | 12.3      | "    | 6.9            | 14.2      | "    | 8.1            | 10.5      | "    | 6.9            | 14.2      | "    | 8.1            | 10.5      |
| 9      | 9.0              | "    | 4.3            | 11.6      | "    | 6.5            | 15.4      | -6.1 | 9.6            | 12.0      | "    | 7.4            | 12.9      | "    | 7.5            | 15.5      | "    | 9.4            | 10.5      | "    | 7.5            | 15.5      | "    | 9.4            | 10.5      |
| 10     | 9.1              | "    | 4.4            | 11.6      | "    | 6.7            | 15.4      | -6.1 | 9.6            | 12.5      | -4.7 | 7.8            | 13.5      | "    | 7.9            | 14.6      | "    | 8.5            | 10.5      | "    | 7.9            | 14.6      | "    | 8.5            | 10.5      |
| 11     | 10.1             | "    | 5.4            | 12.7      | "    | 7.7            | 15.4      | -6.1 | 9.6            | 12.5      | "    | 7.8            | 13.5      | "    | 8.1            | 14.6      | "    | 7.9            | 10.5      | "    | 8.1            | 14.6      | "    | 7.9            | 10.5      |
|        | 10.1             | "    | 5.4            | 12.7      | "    | 7.7            | 15.4      | -6.1 | 9.6            | 12.0      | "    | 7.3            | 13.3      | "    | 7.9            | 14.0      | "    | 7.9            | 10.5      | "    | 7.9            | 14.0      | "    | 7.9            | 10.5      |
| Midn't | 11.1             | "    | 6.4            | 13.3      | -5.1 | 8.2            | 15.4      | -6.1 | 9.6            | 10.5      | 4.8  | 5.7            | 12.7      | -5.5 | 9.2            | 13.5      | -6.0 | 7.5            | 10.5      | "    | 9.2            | 13.5      | -6.0 | 7.5            | 10.5      |

Readings irregular.

|                         | Fath. | Feet. | Inch. |
|-------------------------|-------|-------|-------|
| May 2. Sounding at noon | 7     | 1     | 0     |
| " 3. " "                | 7     | 2     | 0     |
| " 4. " "                | 7     | 1     | 0     |
| " 5. " "                | 6     | 5     | 0     |
| " 6. No sounding.       |       |       |       |
| " 7. Sounding at noon   | 6     | 3     | 0     |
| " 8. " "                | 7     | 2     | 0     |
| " 9. " "                | 7     | 1     | 6     |

Correction derived from sounding and curves.

From this day there is but one reading at each half hour.

Correction from sounding and curves.

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## May, 1854.

| Mean solar hour | 10th | Red. to level | Ref. obs. | 11th | Red. to level | Ref. obs. | 12th | Red. to level | Ref. obs. | 13th | Red. to level | Ref. obs. | 14th | Red. to level | Ref. obs. | 15th | Red. to level | Ref. obs. |
|-----------------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|------|---------------|-----------|
| 1               | 12.5 | -6.0          | 6.5       | 17.0 | "             | 10.8      | 17.4 | -6.3          | 11.1      | 17.3 | -6.5          | 10.8      | 18.3 | -6.7          | 11.6      | 20.6 | -6.7          | 13.9      |
| 2               | 9.8  | "             | 3.8       | 13.7 | "             | 7.4       | 16.0 | "             | 9.7       | 16.1 | "             | 9.6       | 16.2 | "             | 9.5       | 18.8 | "             | 12.1      |
| 3               | 9.5  | "             | 3.5       | 11.5 | "             | 5.2       | 13.7 | "             | 7.4       | 15.3 | "             | 8.8       | 12.3 | "             | 5.6       | 17.6 | "             | 10.9      |
| 4               | 8.3  | "             | 2.3       | 9.6  | "             | 3.3       | 10.8 | "             | 4.5       | 14.0 | "             | 7.5       | 9.9  | "             | 3.2       | 16.5 | "             | 9.8       |
| 5               | 8.0  | "             | 2.0       | 8.3  | "             | 2.0       | 8.4  | "             | 2.1       | ...  | "             | ...       | ...  | "             | ...       | 15.4 | "             | 8.7       |
| 6               | 8.0  | "             | 2.0       | 9.7  | "             | 3.2       | 7.3  | "             | 1.0       | ...  | "             | ...       | ...  | "             | ...       | 10.4 | "             | 3.7       |
| 7               | 8.5  | -6.1          | 2.4       | "    | "             | 9.2       | "    | 2.9           | ...       | ...  | "             | ...       | ...  | "             | ...       | 9.0  | "             | 2.3       |
| 8               | 9.2  | "             | 3.1       | 11.8 | "             | 5.5       | 10.4 | "             | 4.1       | ...  | "             | ...       | ...  | "             | ...       | 8.4  | "             | 1.7       |
| 9               | 11.7 | "             | 5.6       | 15.4 | "             | 9.1       | 12.3 | "             | 6.0       | ...  | "             | ...       | ...  | "             | ...       | 9.0  | "             | 2.3       |
| 10              | 12.5 | "             | 6.4       | 15.0 | "             | 8.7       | 14.2 | "             | 7.9       | 16.5 | -6.6          | 9.9       | 12.3 | "             | 5.6       | 10.4 | "             | 3.7       |
| 11              | 14.4 | "             | 8.3       | 15.0 | "             | 9.7       | 15.4 | "             | 9.1       | 18.4 | "             | 11.8      | 13.5 | "             | 6.8       | 12.6 | "             | 5.9       |
| 12              | 15.0 | "             | 8.9       | 16.8 | "             | 10.5      | 16.0 | "             | 9.7       | 19.0 | "             | 12.4      | 15.2 | "             | 8.5       | 14.5 | "             | 7.8       |
| 13              | 15.2 | "             | 8.1       | 16.8 | "             | 10.5      | 16.5 | "             | 10.2      | 18.4 | "             | 11.8      | 17.8 | "             | 11.1      | ...  | "             | ...       |
| 14              | 16.4 | -6.2          | 7.2       | 16.0 | -6.3          | 9.7       | 17.2 | -6.2          | 11.0      | 18.0 | -6.7          | 11.3      | 18.0 | "             | 11.3      | 16.6 | "             | 9.9       |
| 15              | 12.3 | "             | 6.1       | 14.6 | "             | 8.3       | 16.4 | "             | 10.0      | 16.4 | "             | 9.7       | 16.6 | "             | 9.9       | 18.9 | "             | 12.2      |
| 16              | 10.3 | "             | 4.1       | 13.0 | "             | 6.7       | 13.4 | "             | 7.2       | 14.4 | "             | 7.7       | 14.7 | "             | 8.0       | 19.0 | "             | 12.3      |
| 17              | 9.7  | "             | 3.5       | "    | "             | "         | "    | "             | "         | "    | "             | "         | "    | "             | "         | 18.1 | "             | 11.4      |
| 18              | 8.4  | "             | 2.2       | 12.1 | "             | 5.8       | 9.0  | "             | 2.8       | 12.0 | "             | 5.3       | 12.5 | "             | 5.8       | 17.1 | "             | 10.6      |
| 19              | 8.4  | "             | 2.2       | "    | "             | 8.3       | "    | 2.1           | ...       | ...  | "             | ...       | ...  | "             | ...       | ...  | "             | ...       |
| 20              | 8.4  | "             | 2.2       | 9.7  | "             | 3.4       | 7.2  | -6.3          | 0.9       | 9.8  | "             | 3.1       | 10.6 | "             | 3.9       | 15.5 | "             | 8.8       |
| 21              | 9.2  | "             | 3.0       | 8.6  | "             | 2.3       | "    | "             | 8.9       | "    | 2.2           | "         | "    | "             | "         | ...  | "             | ...       |
| 22              | 10.5 | "             | 4.1       | 7.6  | "             | 1.3       | 7.2  | "             | 0.9       | 8.0  | "             | 1.3       | 9.0  | "             | 2.3       | 12.3 | "             | 5.6       |
| 23              | 11.0 | "             | 4.8       | 10.3 | "             | 2.9       | 8.1  | "             | 1.8       | 8.0  | "             | 1.3       | 8.2  | "             | 1.5       | ...  | "             | ...       |
| 24              | 12.7 | "             | 6.5       | 12.4 | "             | 4.0       | 9.5  | "             | 3.2       | 9.3  | "             | 2.6       | 7.5  | "             | 0.8       | 10.3 | "             | 3.6       |
| 25              | 12.7 | "             | 6.5       | 12.4 | "             | 6.1       | 10.7 | "             | 4.4       | 11.1 | "             | 4.4       | 8.0  | "             | 1.3       | 7.9  | "             | 1.2       |
| 26              | 14.5 | "             | 8.3       | 15.0 | "             | 8.7       | 13.7 | -6.4          | 7.3       | 12.9 | "             | 6.2       | 10.2 | "             | 3.5       | 7.5  | "             | 0.8       |
| 27              | 15.4 | "             | 9.2       | 17.4 | "             | 11.1      | 15.5 | "             | 8.1       | 11.5 | "             | 7.8       | 11.8 | "             | 5.1       | 9.3  | "             | 0.5       |
| 28              | 16.2 | "             | 10.0      | 19.5 | "             | 13.2      | 18.2 | "             | 11.8      | 17.4 | "             | 10.7      | 14.7 | "             | 8.0       | 12.1 | -6.8          | 5.3       |
| 29              | 17.1 | "             | 10.9      | 20.0 | "             | 13.7      | 19.5 | "             | 13.1      | 20.3 | "             | 13.6      | 18.2 | "             | 11.5      | 16.5 | -6.9          | 9.6       |
| 30              | 17.8 | "             | 11.6      | 19.6 | "             | 13.3      | "    | "             | 13.1      | 20.1 | "             | 13.4      | 20.2 | "             | 13.5      | 19.0 | -7.0          | 12.0      |
| Mean            | 18.0 | "             | 11.8      | 18.8 | "             | 12.5      | 19.5 | "             | 13.1      | 20.1 | "             | 13.4      | 20.2 | "             | 13.5      | 19.0 | -7.0          | 12.0      |

May 10 and 11. No sounding.

" 12. Sounding at noon 8 fathoms (last sounding recorded). Correction by sounding and curves.

# RECORD AND REDUCTION OF THE TIDES.

31

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### May, 1854.

| Mean solar hour. | 16th. | Ref. obs. | 17th. | Ref. obs. | 18th. | Ref. obs. | 19th. | Ref. obs. | 20th. | Ref. obs. | 21st. | Ref. obs. | 22d. | Ref. obs. | 23d. | Ref. obs. | 24th. | Ref. obs. |
|------------------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|------|-----------|------|-----------|-------|-----------|
| 1                | 10.6  | 12.4      | 18.0  | 10.8      | 17.6  | 10.4      | 14.0  | 6.9       | 12.0  | 5.2       | 12.0  | 5.2       | 10.3 | 3.4       | 13.0 | 5.6       | 16.2  | 7.5       |
| 2                | 10.6  | 12.4      | 18.0  | 11.8      | 19.4  | 11.2      | 19.0  | 11.8      | 13.0  | 7.9       | 13.2  | 6.4       | 11.6 | 4.8       | 10.3 | 3.4       | 12.2  | 4.8       |
| 3                | 17.0  | 9.8       | 20.0  | 12.8      | 19.7  | 12.5      | 10.4  | 9.3       | 14.1  | 7.3       | 12.5  | 5.7       | 10.3 | 3.4       | 11.3 | 3.8       | 11.0  | 3.5       |
| 4                | 16.0  | 8.8       | 18.0  | 10.8      | 19.7  | 12.5      | 17.7  | 10.6      | 15.2  | 8.5       | 14.2  | 7.4       | 11.5 | 4.6       | 12.0 | 4.4       | 13.0  | 4.1       |
| 5                | 14.4  | 7.2       | 16.2  | 9.0       | 19.7  | 12.5      | 19.8  | 11.7      | 15.5  | 8.8       | 15.6  | 8.8       | 13.8 | 5.9       | 13.7 | 6.1       | 13.0  | 4.0       |
| 6                | 12.5  | 5.3       | 14.3  | 7.1       | 17.8  | 10.6      | 18.8  | 11.7      | 15.5  | 8.8       | 16.8  | 10.0      | 15.2 | 8.2       | 15.2 | 7.5       | 13.5  | 4.5       |
| 7                | 10.0  | 2.8       | 12.0  | 5.4       | 15.8  | 8.6       | 17.4  | 10.4      | 16.5  | 9.8       | 17.4  | 10.6      | 16.5 | 9.5       | 17.0 | 11.1      | 16.6  | 7.5       |
| 8                | 9.0   | 1.8       | 11.3  | 4.1       | 14.3  | 7.1       | 16.0  | 9.0       | 16.5  | 9.8       | 17.9  | 11.1      | 17.0 | 10.6      | 18.2 | 10.4      | 17.8  | 8.6       |
| 9                | 9.7   | 2.5       | 10.2  | 3.0       | 13.0  | 5.8       | 14.4  | 7.4       | 14.9  | 8.2       | 17.0  | 10.2      | 17.0 | 10.6      | 19.1 | 11.2      | 18.1  | 9.0       |
| 10               | 10.0  | 3.0       | 10.2  | 3.0       | 10.0  | 2.8       | 12.4  | 5.4       | 13.6  | 6.9       | 15.7  | 8.9       | 16.5 | 9.5       | 17.5 | 9.5       | 16.7  | 7.4       |
| 11               | 12.4  | 5.2       | 13.4  | 6.2       | 9.0   | 1.8       | 11.7  | 4.7       | 12.8  | 6.1       | 14.6  | 7.8       | 15.1 | 8.1       | 16.0 | 8.0       | 15.1  | 5.8       |
| Noon             | 14.3  | 7.1       | 14.6  | 7.4       | 10.3  | 3.1       | 10.6  | 3.6       | 12.1  | 5.4       | 12.8  | 6.0       | 13.7 | 6.7       | 15.3 | 7.3       | 14.5  | 5.2       |
| 1                | 16.2  | 9.0       | 15.9  | 8.7       | 14.0  | 6.8       | 10.8  | 3.8       | 11.5  | 4.8       | 11.2  | 4.4       | 12.0 | 5.0       | 14.2 | 6.2       | 13.8  | 4.5       |
| 2                | 17.0  | 9.8       | 17.6  | 10.4      | 15.2  | 8.0       | 11.8  | 4.8       | 11.0  | 4.3       | 10.5  | 3.7       | 11.0 | 4.0       | 13.0 | 5.0       | 13.1  | 3.8       |
| 3                | 17.6  | 10.4      | 17.8  | 10.6      | 16.3  | 9.1       | 12.8  | 5.8       | 10.5  | 3.8       | 10.5  | 3.7       | 9.5  | 2.5       | 12.0 | 3.0       | 12.1  | 2.8       |
| 4                | 16.3  | 9.1       | 16.7  | 9.5       | 16.8  | 9.6       | 14.2  | 7.2       | 10.8  | 4.1       | 11.7  | 4.9       | 11.0 | 4.0       | 11.5 | 3.3       | 11.3  | 2.0       |
| 5                | 14.4  | 7.2       | 14.0  | 6.8       | 15.8  | 8.6       | 15.7  | 8.7       | 12.7  | 6.0       | 12.0  | 5.8       | 11.7 | 4.7       | 12.4 | 4.0       | 12.5  | 3.2       |
| 6                | 12.0  | 4.8       | 12.8  | 5.6       | 14.0  | 6.8       | 17.2  | 10.2      | 14.3  | 7.6       | 13.7  | 6.9       | 13.1 | 6.1       | 14.0 | 5.0       | 14.2  | 4.9       |
| 7                | 10.8  | 3.6       | 10.6  | 3.4       | 13.3  | 6.1       | 17.2  | 10.2      | 14.0  | 8.2       | 14.5  | 7.7       | 14.1 | 7.0       | 15.5 | 7.0       | 16.5  | 7.3       |
| 8                | 9.5   | 2.3       | 10.0  | 2.8       | 12.4  | 5.2       | 15.7  | 8.7       | 15.4  | 8.7       | 15.4  | 8.6       | 16.4 | 9.3       | 16.6 | 8.1       | 18.4  | 9.2       |
| 9                | 11.7  | 4.5       | 10.4  | 3.2       | 11.3  | 4.2       | 15.0  | 8.1       | 15.4  | 8.7       | 15.4  | 8.6       | 16.5 | 9.3       | 18.3 | 9.7       | 19.4  | 10.2      |
| 10               | 13.5  | 6.3       | 12.0  | 4.8       | 11.5  | 4.4       | 14.0  | 7.1       | 14.2  | 7.4       | 14.7  | 7.9       | 16.5 | 9.3       | 20.0 | 11.4      | 20.1  | 10.9      |
| 11               | 15.3  | 8.1       | 13.6  | 6.4       | 12.4  | 5.3       | 13.0  | 6.1       | 13.3  | 6.5       | 14.0  | 7.2       | 16.5 | 9.2       | 20.0 | 11.4      | 21.4  | 12.2      |
| Midn't           | 16.7  | 9.5       | 14.8  | 7.6       | 12.8  | 5.7       | 12.5  | 5.7       | 12.4  | 5.6       | 12.6  | 5.8       | 15.0 | 7.7       | 18.0 | 9.3       | 22.1  | 12.9      |

From about the middle of May to the end of the series the corrections change very little from day to day, and are given below:—

May 16, Correction —7.2

" 17, " —7.3

" 18, " —7.2

" 19, " —7.0

" 20, " —6.7

May 21, Correction —6.8

" 22, " —7.0

" 23, " —8.0

" 24, " —9.1

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| May, 1854.               |              |              |              |              |              |              |              |              |              |              |              | June, 1854.              |              |              |              |              |             |              |
|--------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------------------|--------------|--------------|--------------|--------------|-------------|--------------|
| Mean<br>solar<br>hour    | 25th<br>obs. | Ref.<br>obs. | 26th<br>obs. | Ref.<br>obs. | 27th<br>obs. | Ref.<br>obs. | 28th<br>obs. | Ref.<br>obs. | 29th<br>obs. | Ref.<br>obs. | 30th<br>obs. | Ref.<br>obs.             | 31st<br>obs. | Ref.<br>obs. | 1st.<br>obs. | Ref.<br>obs. | 2d.<br>obs. | Ref.<br>obs. |
| 1                        | 19.8         | 10.6         | 17.4         | 8.5          | 21.2         | 12.5         | 19.0         | 10.7         |              |              | 19.0         | 11.5                     |              |              |              |              |             |              |
|                          | 19.0         | 9.8          | 16.6         | 7.7          | 21.2         | 12.5         | 19.0         | 10.7         | 18.4         | 10.8         | 19.5         | 12.0                     | 16.4         | 8.9          | 18.2         | 10.7         | 15.4        | 8.0          |
| 2                        | 17.0         | 7.9          | 14.3         | 5.4          | 18.7         | 10.1         | 18.6         | 10.1         |              |              | 18.1         | 10.6                     |              |              |              |              |             |              |
|                          | 14.5         | 5.4          | 12.4         | 3.6          | 16.0         | 7.4          | 15.5         | 7.4          | 14.3         | 6.7          | 17.2         | 9.5                      | 17.9         | 10.4         | 18.5         | 11.0         | 16.1        | 8.7          |
| 3                        |              |              | 11.8         | 3.0          |              |              |              |              |              |              |              |                          | 18.5         | 11.0         | 18.5         | 11.0         |             |              |
|                          | 12.0         | 2.9          | 11.5         | 2.7          | 14.7         | 6.1          | 12.4         | 4.3          | 12.1         | 4.5          | 16.1         | 8.6                      | 19.0         | 11.5         | 18.2         | 10.7         | 17.0        | 9.6          |
| 4                        | 11.0         | 2.0          | 11.5         | 2.7          |              |              |              |              |              |              |              |                          | 19.0         | 11.5         |              |              | 17.2        | 9.8          |
|                          | 11.0         | 2.0          | 11.5         | 2.7          | 12.5         | 3.9          | 10.8         | 2.8          | 10.0         | 2.5          | 14.3         | 6.8                      | 17.2         | 9.7          | 16.2         | 8.7          | 17.0        | 9.7          |
| 5                        | 11.0         | 2.0          | 11.5         | 2.7          | 11.2         | 2.6          | 10.0         | 2.0          | 9.0          | 1.5          |              |                          |              |              |              |              |             |              |
|                          | 11.5         | 2.5          | 11.5         | 2.7          | 11.0         | 2.4          | 9.5          | 1.6          | 9.0          | 1.5          | 12.4         | 4.9                      | 14.9         | 7.4          | 14.3         | 6.8          | 15.6        | 8.3          |
| 6                        |              |              | 11.8         | 3.0          | 11.0         | 2.4          | 9.5          | 1.6          | 9.0          | 1.5          |              |                          |              |              |              |              |             |              |
|                          | 13.5         | 4.5          | 12.5         | 3.7          | 12.4         | 3.8          | 9.5          | 1.6          | 9.0          | 1.5          | 10.2         | 2.7                      | 12.9         | 5.4          | 13.4         | 5.9          | 14.2        | 5.9          |
| 7                        |              |              |              |              |              |              | 9.5          | 1.6          | 9.0          | 1.5          | 10.0         | 2.5                      |              |              |              |              |             |              |
|                          |              |              |              |              |              |              | 10.1         | 2.3          | 9.0          | 1.5          | 10.0         | 2.5                      | 12.0         | 4.5          | 12.6         | 5.1          | 12.8        | 5.5          |
| 8                        |              |              |              |              |              |              |              |              | 9.0          | 1.5          | 10.0         | 2.5                      | 11.2         | 3.7          | 12.0         | 4.5          |             |              |
|                          | 17.4         | 8.4          | 15.2         | 6.4          | 15.2         | 6.7          | 11.7         | 3.9          | 10.2         | 2.7          | 10.0         | 2.5                      | 10.0         | 2.5          | 11.5         | 4.0          | 12.0        | 4.7          |
| 9                        | 18.2         | 9.2          |              |              |              |              |              |              | 11.3         | 3.8          | 10.0         | 2.5                      | 11.5         | 4.0          | 11.3         | 4.0          |             |              |
|                          | 19.0         | 10.0         | 16.3         | 7.5          | 17.3         | 8.8          | 13.0         | 5.2          | 12.4         | 4.9          | 12.4         | 4.9                      | 10.5         | 3.0          | 11.5         | 4.0          | 11.0        | 3.7          |
| 10                       | 19.0         | 10.0         |              |              | 18.2         | 9.7          |              |              |              |              |              |                          |              |              | 11.5         | 4.0          | 11.0        | 3.7          |
|                          | 18.4         | 9.4          | 17.2         | 8.4          | 18.2         | 9.7          | 14.7         | 6.9          | 14.4         | 6.9          | 13.8         | 6.3                      | 12.6         | 5.1          | 12.0         | 4.5          | 11.0        | 3.7          |
| 11                       |              |              |              |              | 18.0         | 9.5          | 15.4         | 7.6          |              |              |              |                          |              |              |              |              | 11.5        | 4.2          |
|                          | Noon         | 16.0         | 7.0          | 18.4         | 9.6          | 17.5         | 9.0          | 16.5         | 8.7          | 15.5         | 8.0          | 14.9                     | 7.4          | 13.7         | 6.2          | 13.0         | 5.5         | 11.8         |
| 1                        |              |              | 18.5         | 9.7          |              |              | 15.7         | 7.9          | 16.0         | 8.5          | 15.3         | 7.8                      | 14.8         | 7.3          | 14.5         | 7.0          | 12.4        | 5.1          |
|                          | 1            | 15.0         | 6.0          | 18.5         | 9.7          | 16.6         | 8.1          | 15.1         | 7.3          | 16.0         | 8.5          | 15.3                     | 7.8          | 14.4         | 7.0          |              |             |              |
| 2                        |              |              | 17.7         | 8.9          |              |              | 15.6         | 8.1          |              |              | 15.6         | 8.1                      | 16.0         | 8.5          | 15.4         | 7.9          |             |              |
|                          | 2            | 14.0         | 5.0          | 17.1         | 8.3          | 14.2         | 5.7          | 13.5         | 5.7          | 15.1         | 7.6          | 16.0                     | 8.5          | 16.0         | 8.5          | 14.6         | 7.1         | 12.8         |
| 3                        |              |              |              |              |              |              |              |              | 16.0         | 8.5          | 16.0         | 8.5                      | 16.0         | 8.5          |              |              |             |              |
|                          | 3            | 13.2         | 4.2          | 16.0         | 7.2          | 12.3         | 3.8          | 11.7         | 3.9          | 14.2         | 6.7          | 16.0                     | 8.5          | 16.0         | 8.5          | 15.0         | 7.5         | 13.5         |
| 4                        |              |              |              |              | 9.5          | 1.1          | 10.8         | 3.1          |              |              |              |                          | 15.2         | 7.7          | 15.4         | 7.9          | 15.5        | 8.0          |
|                          | 4            | 12.0         | 3.0          | 14.8         | 6.0          | 9.0          | 0.5          | 10.0         | 2.3          | 12.3         | 4.8          | 14.2                     | 6.7          | 15.0         | 7.5          | 15.5         | 8.0         | 14.4         |
| 5                        | 11.4         | 2.4          |              |              |              |              |              |              |              |              |              |                          |              |              | 15.5         | 8.0          | 15.0        | 7.8          |
|                          | 5            | 11.0         | 2.0          | 13.6         | 4.8          | 9.5          | 1.0          | 10.0         | 2.3          | 11.6         | 4.1          | 12.8                     | 5.3          | 13.5         | 6.0          | 15.5         | 8.0         | 15.0         |
| 6                        | 12.1         | 3.1          | 12.2         | 3.4          |              |              |              |              | 10.9         | 2.3          |              |                          | 11.2         | 3.7          |              |              |             |              |
|                          | 6            | 11.0         | 2.0          | 12.2         | 3.4          | 10.0         | 1.5          | 11.3         | 3.6          | 10.2         | 2.7          | 10.0                     | 2.5          | 12.7         | 5.2          | 15.0         | 7.6         | 14.0         |
| 7                        | 13.3         | 4.3          | 12.2         | 3.4          | 10.4         | 1.9          | 12.3         | 4.6          | 9.1          | 1.6          | 10.0         | 2.5                      | 11.7         | 4.2          | 14.2         | 6.8          | 13.4        | 6.2          |
|                          |              |              | 12.6         | 3.9          |              |              |              |              | 9.1          | 1.6          | 10.0         | 2.5                      | 11.5         | 4.0          |              |              |             |              |
| 8                        | 15.7         | 6.8          | 13.2         | 4.5          | 12.0         | 3.6          | 14.2         | 6.5          | 9.1          | 1.6          | 11.0         | 3.5                      | 11.0         | 3.5          | 13.0         | 5.6          | 12.8        | 5.6          |
|                          |              |              |              |              |              |              |              |              | 10.2         | 2.7          |              |                          | 11.0         | 3.5          |              |              |             |              |
| 9                        |              |              |              |              |              |              |              |              | 11.3         | 3.8          | 13.0         | 5.5                      | 11.0         | 3.5          | 12.0         | 4.3          | 12.4        | 5.2          |
|                          | 9            | 17.4         | 8.5          | 15.3         | 6.6          | 14.2         | 5.8          | 15.0         | 7.3          |              |              |                          | 11.5         | 4.0          | 11.4         | 4.0          | 12.0        | 4.8          |
| 10                       | 19.5         | 10.6         | 17.6         | 8.9          | 16.4         | 8.0          | 16.1         | 8.4          | 13.7         | 6.2          | 14.4         | 6.9                      | 12.0         | 4.5          | 11.0         | 3.6          | 12.0        | 4.8          |
|                          | 19.7         | 10.8         |              |              |              |              |              |              |              |              |              |                          | 11.5         | 4.1          | 12.0         | 4.8          |             |              |
| 11                       | 19.7         | 10.8         | 19.4         | 10.7         | 18.1         | 9.8          | 17.4         | 9.7          | 16.2         | 8.7          | 15.1         | 7.6                      | 14.2         | 6.7          | 12.2         | 4.8          | 12.0        | 4.8          |
|                          |              |              | 20.1         | 11.4         | 18.7         | 10.4         | 18.0         | 10.3         |              |              |              |                          |              |              | 12.3         | 5.1          |             |              |
| Midn't                   | 19.7         | 10.8         | 20.1         | 11.4         | 19.0         | 10.7         | 18.6         | 10.9         | 17.4         | 9.9          | 16.2         | 8.7                      | 15.8         | 8.3          | 14.3         | 6.9          | 12.7        | 5.5          |
| May 25. Correction — 9.0 |              |              |              |              |              |              |              |              |              |              |              | May 30. Correction — 7.5 |              |              |              |              |             |              |
| " 26. " — 8.8            |              |              |              |              |              |              |              |              |              |              |              | 31. " — 7.5              |              |              |              |              |             |              |
| " 27. " — 8.1            |              |              |              |              |              |              |              |              |              |              |              | June 1. " — 7.5          |              |              |              |              |             |              |
| " 28. " — 7.8            |              |              |              |              |              |              |              |              |              |              |              | " 2. " — 7.1             |              |              |              |              |             |              |
| " 29. " — 7.5            |              |              |              |              |              |              |              |              |              |              |              |                          |              |              |              |              |             |              |

# RECORD AND REDUCTION OF THE TIDES.

33

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### June, 1854.

| Mean solar hour. | 3d. Ref. obs. | 4th. Ref. obs. | 5th. Ref. obs. | 6th. Ref. obs. | 7th. Ref. obs. | 8th. Ref. obs. | 9th. Ref. obs. | 10th. Ref. obs. | 11th. Ref. obs. |
|------------------|---------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|-----------------|
| 1                | 14.2 7.1      | 13.0 6.3       | 12.4 6.0       | 12.5 6.1       | 12.3 5.6       | 12.8 5.5       | ---            | 16.4 8.2        | 18.0 9.5        |
| 2                | 15.8 8.7      | 14.0 7.4       | 12.8 6.4       | 12.5 6.1       | 12.5 5.8       | 11.8 4.4       | ---            | 14.9 6.7        | 19.9 10.5       |
| 3                | 16.4 9.3      | 15.2 8.6       | 13.8 7.4       | 12.9 6.5       | 12.0 5.3       | 11.4 4.0       | ---            | 12.1 3.9        | 18.0 9.5        |
| 4                | 16.6 9.6      | 16.0 9.4       | 15.2 8.8       | 14.2 7.8       | 11.0 4.3       | 14.5 7.0       | ---            | 12.0 3.7        | 15.2 6.7        |
| 5                | ---           | ---            | 15.4 9.0       | 14.6 8.4       | 15.6 8.8       | 14.7 7.4       | ---            | 10.4 2.1        | 10.4 1.8        |
| 6                | ---           | ---            | 15.8 9.1       | 15.0 8.6       | 16.0 9.2       | 15.0 7.7       | ---            | 10.9 2.6        | 10.4 1.8        |
| 7                | ---           | ---            | 16.0 9.6       | 15.6 9.2       | 17.0 9.1       | 15.6 8.2       | ---            | 11.5 3.2        | 10.4 1.8        |
| 8                | ---           | ---            | 16.1 9.7       | 16.0 9.6       | 15.5 8.7       | 16.8 9.3       | ---            | 11.1 2.7        | 13.2 4.6        |
| 9                | 11.5 4.5      | ---            | 14.1 7.7       | 16.5 10.1      | 17.1 10.2      | 16.6 9.1       | ---            | ---             | 16.0 7.4        |
| 10               | 12.0 5.0      | ---            | 12.2 5.8       | 14.8 8.4       | 15.5 8.5       | 16.2 8.6       | 16.0 8.0       | 20.0 11.7       | 18.0 9.4        |
| 11               | 12.5 5.5      | ---            | 11.5 5.1       | 14.5 8.1       | 14.5 7.5       | 13.4 5.8       | 13.9 5.9       | 18.0 9.7        | 18.0 9.4        |
| Noon             | 13.0 6.0      | ---            | 11.1 4.7       | 13.3 6.9       | 12.9 5.9       | 12.5 4.9       | 12.6 4.6       | 17.6 9.3        | 17.2 8.6        |
| 1                | 13.5 6.5      | ---            | 11.1 4.7       | 11.6 5.2       | 11.9 4.9       | 11.8 4.2       | 12.0 4.6       | 16.4 8.1        | 16.8 8.2        |
| 2                | 14.0 7.0      | 11.4 5.0       | 11.2 4.8       | 10.8 4.4       | 11.4 4.4       | 10.4 2.7       | 10.3 2.3       | ---             | ---             |
| 3                | 14.5 7.6      | 12.4 6.0       | 11.4 5.0       | 10.5 4.0       | 10.5 3.4       | 9.5 1.8        | 9.4 1.4        | 13.2 4.9        | 15.0 6.4        |
| 4                | 15.0 8.1      | 13.6 7.2       | 12.4 6.0       | 10.9 4.4       | 11.5 4.1       | 9.8 2.1        | ---            | ---             | ---             |
| 5                | 15.0 8.1      | ---            | ---            | 11.4 4.9       | 12.6 5.5       | 10.5 2.8       | 10.3 2.3       | 11.7 3.3        | 14.2 5.6        |
| 6                | 14.8 8.0      | 14.4 8.0       | 13.6 7.2       | 13.2 6.6       | 14.0 6.9       | 11.9 4.1       | 11.4 3.4       | 10.2 1.8        | 12.9 4.3        |
| 7                | 14.6 7.8      | 14.4 8.0       | 14.8 8.4       | 14.8 8.2       | 14.7 7.5       | 13.1 5.3       | 12.6 4.5       | 9.0 0.6         | 12.0 3.4        |
| 8                | 14.0 7.2      | 15.0 8.6       | 14.4 8.0       | 16.2 9.6       | 17.0 9.8       | 14.0 6.2       | 16.4 8.3       | 12.0 3.6        | 16.6 2.0        |
| 9                | 13.4 6.6      | 15.0 8.6       | 15.2 8.8       | 17.0 10.4      | 18.0 10.8      | 16.2 8.4       | 19.5 11.4      | 15.4 7.0        | 13.6 4.9        |
| 10               | 13.0 6.2      | 14.0 7.6       | 15.6 9.2       | 16.6 10.0      | 18.4 11.1      | 18.6 10.8      | 21.0 12.9      | ---             | 16.2 7.5        |
| 11               | 12.6 5.2      | 13.0 6.6       | 14.6 8.2       | 16.2 9.6       | 18.0 10.7      | 19.4 11.6      | 20.6 12.5      | ---             | 19.2 10.5       |
| Midn't           | 12.3 5.6      | 12.5 6.1       | 13.2 6.8       | 16.2 9.6       | 17.2 9.9       | 19.0 11.2      | 20.0 11.9      | ---             | 20.2 11.5       |
|                  | 13.0 6.3      | 12.0 5.6       | 12.6 6.2       | 15.2 8.6       | 14.0 6.7       | 18.0 10.2      | ---            | ---             | 21.4 12.6       |

June 3. Correction —7.0

June 4. Correction —6.4

June 5. Correction —6.4

" 6. " —6.4

" 7. " —7.0

" 8. " —7.6

" 9. " —8.0

The record on this day is defective.

" 10. " —8.3

Readings between the full hours are less frequent than before, and are generally

" 11. " —8.6

given only near high or low water.



## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

## June, 1854.

| Mean<br>star<br>hour | 12th<br>Ref.<br>obs.   | 13th<br>Ref.<br>obs. | 14th<br>Ref.<br>obs. | 15th<br>Ref.<br>obs. | 16th<br>Ref.<br>obs. | 17th<br>Ref.<br>obs. | 18th<br>Ref.<br>obs. | 19th<br>Ref.<br>obs. | 20th<br>Ref.<br>obs. |
|----------------------|------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| 1                    | 22.0 13.2<br>21.0 12.1 | 21.0 12.1            | 21.0 12.1            | 20.1 11.3            | 16.0 7.3             | 17.3 8.6             | 14.1 6.1             | 14.0 6.2             | 13.5 5.8             |
| 2                    | 21.3 12.7<br>19.8 11.0 | 19.9 11.0            | 21.0 12.1            | 21.1 12.3            | 17.2 8.5             | 18.6 9.9             | 15.6 7.3             | 15.1 7.1             | 12.9 5.2             |
| 3                    | 18.5 9.7               | 18.2 9.3             | 20.2 11.3            | 21.1 12.3            | 19.0 10.3            | 19.2 10.5            | 17.0 8.7             | 15.9 8.2             | 12.9 5.2             |
| 4                    | 15.2 6.4               | 18.0 9.4             | 19.6 10.7            | 20.9 12.1            | 20.0 11.4            | 19.9 11.3            | 18.2 9.9             | 16.2 8.6             | 14.0 6.2             |
| 5                    | 12.3 3.7               | 13.2 4.3             | 15.3 6.4             | 16.3 7.6             | 19.0 10.3            | 17.6 9.0             | 18.4 10.2            | 18.0 10.4            | 15.6 7.8             |
| 6                    | 10.4 1.6               | 11.6 2.7             | 12.2 3.3             | 14.4 5.7             | 16.8 8.1             | 16.4 7.8             | 18.0 9.8             | 18.1 10.5            | 16.4 8.6             |
| 7                    | 10.4 1.6               | 10.0 1.1             | 10.5 1.6             | 11.5 2.8             | 14.3 5.6             | 14.2 5.6             | 17.5 9.1             | 18.0 10.4            | 17.6 9.8             |
| 8                    | 13.2 4.4               | 10.0 1.1             | 10.5 1.6             | 10.8 2.1             | 12.8 4.1             | 12.4 3.8             | 17.0 8.8             | 17.8 10.2            | 17.7 9.9             |
| 9                    | 15.5 6.7               | 9.1 0.2              | 12.6 3.7             | 10.0 1.4             | 11.4 2.7             | 11.6 3.0             | 13.4 5.3             | 15.6 8.0             | 17.6 9.8             |
| 10                   | 16.6 7.8               | 12.2 3.3             | 14.0 5.1             | 11.0 2.1             | 11.2 2.5             | 12.2 3.6             | 12.5 4.4             | 15.0 7.4             | 16.5 8.7             |
| 11                   | 18.6 9.8<br>19.2 10.4  | 16.4 7.5             | 16.0 7.1             | 14.5 5.8             | 13.0 4.3             | 12.6 4.0             | 11.5 3.6             | 14.0 6.4             | 14.8 7.0             |
| Noon                 | 17.6 8.8               | 18.4 9.5             | 17.6 8.7             | 16.2 7.5             | 14.6 5.9             | 14.5 5.9             | 11.4 3.4             | 13.0 5.4             | 11.5 6.7             |
| 1                    | 15.8 7.0               | 19.2 10.3            | 19.1 10.2            | 17.2 8.5             | 15.9 7.2             | 15.9 7.3             | 12.0 4.0             | 12.0 4.4             | 14.0 6.2             |
| 2                    | 13.8 5.0               | 19.2 10.3            | 19.1 10.2            | 17.2 8.5             | 17.6 8.9             | 17.3 8.7             | 13.1 5.3             | 12.0 4.4             | 13.6 5.8             |
| 3                    | 13.0 4.2               | 17.6 8.7             | 17.4 8.5             | 16.2 7.5             | 16.9 8.2             | 17.0 8.5             | 16.6 8.6             | 13.0 5.4             | 13.0 5.2             |
| 4                    | 11.6 2.8               | 16.2 7.3             | 16.0 7.1             | 15.0 6.3             | 15.5 6.8             | 17.0 8.4             | 14.1 8.3             | 14.0 6.4             | 12.2 4.4             |
| 5                    | 10.3 1.5               | 14.8 5.9             | 14.2 5.3             | 13.4 4.7             | 14.8 6.1             | 16.6 8.0             | 18.5 10.5            | 15.0 7.4             | 14.0 6.1             |
| 6                    | 9.2 0.4                | 14.2 5.3             | 14.0 4.1             | 12.6 3.9             | 14.6 5.9             | 16.1 7.5             | 14.3 6.3             | 16.5 8.9             | 15.0 7.1             |
| 7                    | 9.2 0.4                | 14.0 5.1             | 14.4 5.5             | 11.6 3.9             | 14.2 5.5             | 15.8 7.2             | 13.2 5.2             | 17.4 9.8             | 16.7 8.8             |
| 8                    | 12.4 3.6               | 16.0 7.1             | 16.2 7.3             | 11.0 2.5             | 12.8 4.1             | 15.2 6.7             | 13.6 5.6             | 17.4 9.8             | 17.8 9.9             |
| 9                    | 15.0 6.2               | 12.0 3.1             | 11.0 2.1             | 11.4 2.7             | 12.1 3.7             | 14.2 5.7             | 14.3 6.3             | 16.8 9.1             | 18.4 10.5            |
| 10                   | 18.5 9.7               | 15.0 6.1             | 12.4 3.6             | 13.6 4.9             | 13.0 4.3             | 13.4 4.9             | 15.0 7.1             | 15.5 7.8             | 18.5 10.5            |
| 11                   | 21.0 12.2              | 18.0 9.1             | 15.0 6.2             | 15.0 6.3             | 14.0 5.3             | 14.0 4.6             | 14.0 6.2             | 14.5 6.8             | 16.9 8.9             |
| Midnight             | 20.4 11.5              | 18.0 9.2             | 15.2 6.5             | 13.0 4.6             | 13.4 5.6             | 14.3 6.6             | 15.6 7.6             | 15.6 7.6             | 15.6 7.6             |

June 12. Correction — 5.8

The record on this day is defective, the times being uncertain.

" 13. " — 8.0

June 14. Correction — 8.9

" 15. " — 8.7

" 16. " — 8.7

" 17. " — 8.6

" 18. " — 8.0

" 19. " — 7.6

" 20. " — 7.8

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

June, 1854.

| Mean<br>solar<br>hour. | 21st.<br>obs. | Ref.<br>obs. | 22d.<br>obs. | Ref.<br>obs. | 23d.<br>obs. | Ref.<br>obs. | 24th.<br>obs. | Ref.<br>obs. | 25th.<br>obs. | Ref.<br>obs. | 26th.<br>obs. | Ref.<br>obs. | 27th.<br>obs. | Ref.<br>obs. | 28th.<br>obs. | Ref.<br>obs. | 29th.<br>obs. | Ref.<br>obs. |
|------------------------|---------------|--------------|--------------|--------------|--------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|---------------|--------------|
| 1                      | 14.5          | 6.5          | 15.2         | 6.6          | 16.5         | 7.0          | 21.0          | 10.6         | 20.5          | 10.1         | 19.0          | 8.3          | 22.4          | 12.1         | 20.2          | 10.1         | 21.4          | 11.4         |
| 2                      | 13.2          | 6.2          | 13.8         | 5.8          | 13.9         | 5.3          | 14.7          | 5.2          | 18.0          | 7.6          | 17.0          | 6.3          | 22.4          | 12.1         | 20.2          | 10.1         | 21.4          | 11.4         |
| 3                      | 13.8          | 5.8          | 13.3         | 4.7          | 13.4         | 3.8          | 15.0          | 4.5          | 16.0          | 5.3          | 17.6          | 7.3          | 18.5          | 8.4          | 19.1          | 9.1          | 20.0          | 10.0         |
| 4                      | 14.9          | 5.9          | 13.2         | 3.6          | 14.2         | 3.6          | 14.1          | 3.5          | 15.0          | 4.8          | 17.0          | 6.9          | 16.3          | 6.3          | 18.0          | 8.0          |               |              |
| 5                      | 14.1          | 6.3          | 14.0         | 4.3          | 14.2         | 3.6          | 13.0          | 2.4          | 12.2          | 2.0          | 12.0          | 1.9          | 15.3          | 5.3          | 16.6          | 6.6          |               |              |
| 6                      | 15.7          | 7.6          | 14.6         | 4.9          | 15.1         | 4.4          | 13.4          | 2.8          | 13.4          | 3.2          | 12.2          | 2.1          | 14.4          | 4.4          | 15.5          | 5.5          |               |              |
| 7                      | 16.3          | 8.2          | 15.0         | 5.2          | 15.3         | 4.6          | 14.0          | 3.4          | 13.8          | 3.7          | 12.8          | 2.7          | 13.8          | 3.8          | 13.9          | 3.9          |               |              |
| 8                      | 17.2          | 9.1          | 16.7         | 7.6          | 15.6         | 5.8          | 15.5          | 4.7          | 14.5          | 3.9          | 14.4          | 4.3          | 13.4          | 3.3          | 13.2          | 3.2          | 13.6          | 3.6          |
| 9                      | 17.2          | 9.0          | 17.6         | 8.5          | 18.4         | 8.5          | 16.4          | 5.6          | 16.2          | 5.6          | 16.0          | 5.9          | 14.6          | 4.5          | 14.0          | 4.0          | 14.4          | 4.4          |
| 10                     | 16.2          | 8.0          | 18.5         | 9.4          | 18.4         | 8.5          | 17.5          | 6.7          | 17.0          | 6.4          | 17.2          | 7.1          | 16.4          | 6.3          | 15.5          | 5.5          | 16.2          | 6.2          |
| 11                     | 15.8          | 7.6          | 17.5         | 8.4          | 18.1         | 8.1          | 18.3          | 7.5          | 18.1          | 7.5          | 18.8          | 8.7          | 18.0          | 7.9          | 17.8          | 7.8          | 18.0          | 8.0          |
| Noon                   | 14.6          | 6.4          | 16.6         | 7.4          | 17.8         | 7.8          | 18.9          | 8.1          | 18.9          | 8.3          | 19.8          | 9.7          | 19.4          | 9.3          | 19.1          | 9.1          | 18.4          | 8.4          |
| 1                      | 14.0          | 5.8          | 19.0         | 6.9          | 18.0         | 6.0          | 18.9          | 8.1          | 18.2          | 7.6          | 20.0          | 9.9          | 19.9          | 9.8          | 19.2          | 9.2          | 19.0          | 9.0          |
| 2                      | 13.0          | 4.8          | 15.4         | 6.3          | 15.5         | 5.5          | 15.9          | 5.1          | 16.5          | 5.9          | 18.2          | 8.1          | 17.6          | 7.5          | 18.6          | 8.6          | 19.1          | 9.1          |
| 3                      | 11.2          | 3.0          | 14.4         | 5.3          | 14.0         | 3.9          | 14.7          | 3.9          | 15.7          | 5.1          | 16.4          | 6.3          | 16.8          | 6.7          | 17.5          | 7.5          | 17.5          | 7.5          |
| 4                      | 11.9          | 3.7          | 13.2         | 4.1          | 13.6         | 3.5          | 13.9          | 3.1          | 14.0          | 3.9          | 14.8          | 4.7          | 16.8          | 6.8          | 13.4          | 3.4          |               |              |
| 5                      | 14.6          | 6.3          | 12.5         | 3.3          | 13.2         | 3.0          | 13.2          | 2.4          | 13.3          | 3.2          | 13.8          | 3.8          | 15.1          | 5.1          | 12.1          | 2.1          |               |              |
| 6                      | 16.5          | 8.2          | 13.0         | 3.8          | 13.2         | 2.9          | 12.8          | 2.0          | 12.5          | 2.4          | 13.0          | 2.9          | 13.8          | 3.8          | 12.8          | 2.8          | 12.6          | 2.6          |
| 7                      | 18.4          | 10.0         | 14.6         | 5.4          | 13.2         | 2.9          | 13.5          | 2.7          | 13.6          | 3.1          | 13.0          | 2.9          | 13.0          | 3.0          | 12.5          | 2.5          |               |              |
| 8                      | 19.5          | 11.1         | 14.2         | 3.9          | 14.0         | 3.9          | 15.0          | 4.2          | 14.8          | 4.2          | 15.0          | 4.5          | 15.0          | 4.9          | 13.2          | 3.2          | 13.1          | 3.1          |
| 9                      | 20.0          | 11.6         | 18.0         | 8.7          | 16.0         | 5.7          | 17.0          | 6.2          | 18.0          | 7.5          | 19.4          | 9.3          | 15.0          | 5.0          | 15.1          | 5.1          | 15.2          | 5.3          |
| 10                     | 21.5          | 13.0         | 19.0         | 8.6          | 19.0         | 8.7          | 19.0          | 8.2          | 20.2          | 9.8          | 22.2          | 12.1         | 17.5          | 7.5          | 17.2          | 7.2          | 16.7          | 6.8          |
| 11                     | 20.5          | 12.0         | 21.0         | 10.6         | 21.0         | 10.6         | 21.0          | 10.2         | 21.5          | 10.8         | 22.4          | 12.3         | 20.0          | 10.0         | 19.2          | 9.2          | 17.8          | 8.0          |
| Midn't                 | 14.1          | 5.6          | 20.0         | 10.6         | 21.4         | 11.0         | 21.4          | 11.0         | 21.5          | 11.1         | 22.0          | 11.6         | 21.4          | 11.4         | 21.3          | 11.3         | 19.5          | 9.7          |

June 21. Correction — 8.2

" 23. " —10.0

" 25. " —10.6

" 27. " —10.1

" 28. " —10.0

" 29. " —10.0

June 22. Correction — 9.1

" 24. " —10.8

" 26. " —10.1

Some doubt about the time record in the afternoon.

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| June, 1854.     |                 |                |               | July, 1854.   |                 |                |                |                |                |          |  |  |  |  |  |
|-----------------|-----------------|----------------|---------------|---------------|-----------------|----------------|----------------|----------------|----------------|----------|--|--|--|--|--|
| Mean solar hour | 30th. Ref. obs. | 1st. Ref. obs. | 21. Ref. obs. | 31. Ref. obs. | 10th. Ref. obs. | 5th. Ref. obs. | 6th. Ref. obs. | 7th. Ref. obs. | 9th. Ref. obs. |          |  |  |  |  |  |
| 1               | 19.0 9.2        | 18.5 9.0       | 20.6 11.0     | 14.5 5.9      | 16.3 7.9        | 15.2 6.5       | 15.7 6.7       | 15.0 6.0       | 17.0 7.8       | 15.5 8.3 |  |  |  |  |  |
| 2               | 20.8 11.0       | 19.8 10.3      | 21.0 11.3     | 16.3 7.7      | 16.9 8.2        | 15.6 6.9       | 15.0 6.0       | 17.0 7.8       | 15.5 8.3       | 13.0 5.8 |  |  |  |  |  |
| 3               | 21.0 11.2       | 20.7 11.2      | 21.4 11.7     | 17.3 8.7      | 17.4 8.7        | 16.8 8.1       | 15.0 6.0       | 15.8 5.6       | 11.0 3.9       |          |  |  |  |  |  |
| 4               | 22.0 12.3       | 20.9 11.5      | 21.4 11.7     | 17.8 9.1      | 18.6 9.9        | 17.3 8.6       | 15.6 6.6       | 15.8 5.6       | 9.8 2.7        |          |  |  |  |  |  |
| 5               | 20.4 10.7       | 21.0 11.5      | 21.0 11.6     | 17.6 7.8      | 17.8 9.1        | 18.6 10.0      | 18.1 9.7       | 17.0 8.0       | 16.4 6.2       | 9.5 2.4  |  |  |  |  |  |
| 6               | 19.8 10.1       | 20.7 11.1      |               |               |                 |                |                |                |                |          |  |  |  |  |  |
| 7               | 18.9 8.4        | 19.5 10.1      | 15.7 5.9      | 17.0 8.2      | 18.6 10.0       | 18.6 9.9       | 17.6 8.5       | 17.2 7.9       | 9.8 2.8        |          |  |  |  |  |  |
| 8               | 17.0 7.4        | 17.1 7.7       | 14.4 4.6      | 16.3 7.5      | 18.8 10.2       | 18.9 10.1      | 18.2 9.1       | 18.8 8.6       | 10.5 3.5       |          |  |  |  |  |  |
| 9               | 15.0 5.4        | 15.7 6.3       | 12.7 4.5      | 15.7 6.9      | 17.6 9.0        | 18.4 9.6       | 18.5 9.4       | 18.5 9.4       | 12.4 5.4       |          |  |  |  |  |  |
| 10              | 14.5 5.0        | 14.5 5.1       | 12.0 3.8      | 14.0 5.2      | 15.0 6.4        | 18.2 9.4       | 17.0 7.8       | 18.5 8.3       | 13.8 6.8       |          |  |  |  |  |  |
| 11              | 14.8 5.2        | 12.2 2.8       | 11.7 3.7      | 13.6 4.8      | 14.0 5.4        | 17.0 8.2       | 16.2 7.0       | 16.8 6.6       | 15.4 8.4       |          |  |  |  |  |  |
| Noon            | 18.7 9.1        | 15.0 5.6       | 11.4 2.2      | 13.6 4.8      | 13.0 4.4        | 15.0 6.2       | 15.9 6.7       | 15.5 5.3       | 15.5 8.5       |          |  |  |  |  |  |
| 1               | 18.9 9.3        | 15.1 6.0       | 11.4 2.2      | 13.0 4.4      | 13.0 4.4        | 14.0 5.2       | 14.0 4.8       | 13.5 5.0       | 14.9 7.9       |          |  |  |  |  |  |
| 2               | 18.8 9.2        | 17.2 7.8       | 12.2 3.9      | 13.1 4.5      | 13.2 4.6        | 13.1 4.3       | 13.1 3.9       | 13.1 3.9       | 11.2 4.3       |          |  |  |  |  |  |
| 3               | 17.0 7.4        | 18.1 8.7       | 13.1 5.1      | 16.2 7.4      | 14.0 5.4        | 13.1 4.3       | 13.1 3.9       | 13.1 3.9       | 9.1 2.2        |          |  |  |  |  |  |
| 4               | 15.8 6.2        | 18.3 8.9       | 14.1 6.1      | 17.2 8.4      | 15.0 6.7        | 13.1 4.5       | 13.1 4.2       | 13.2 3.0       | 8.3 1.5        |          |  |  |  |  |  |
| 5               | 15.0 5.4        | 18.3 8.9       | 15.2 6.8      | 18.2 9.4      | 17.2 8.6        | 16.1 7.3       | 14.3 5.1       | 14.2 3.0       | 8.0 1.2        |          |  |  |  |  |  |
| 6               | 14.0 4.4        | 18.7 9.3       | 15.6 7.2      | 18.6 9.8      | 17.4 8.7        | 17.5 8.7       | 17.3 8.1       | 14.2 4.0       | 8.0 1.3        |          |  |  |  |  |  |
| 7               | 13.5 3.9        | 17.1 7.8       | 15.3 6.9      | 18.6 9.8      | 18.0 9.3        | 18.0 9.2       | 18.3 9.1       | 15.3 5.1       | 2.0 2.4        |          |  |  |  |  |  |
| 8               | 13.1 3.8        | 17.2 6.7       | 14.6 6.2      | 18.0 9.2      | 18.5 9.8        | 19.4 10.6      | 19.5 10.3      | 16.6 6.4       | 11.0 4.5       |          |  |  |  |  |  |
| 9               | 13.1 3.8        | 14.7 5.2       | 14.0 5.5      | 17.5 8.7      | 18.0 9.3        | 19.4 10.5      | 20.4 11.2      | 18.0 7.2       | 13.4 6.9       |          |  |  |  |  |  |
| 10              | 14.1 4.5        | 14.5 5.0       | 14.0 5.5      | 16.7 7.9      | 17.4 8.7        | 19.4 10.5      | 20.4 11.2      | 18.0 7.8       | 15.9 9.5       |          |  |  |  |  |  |
| 11              | 15.4 5.8        | 17.5 8.0       | 12.8 4.3      | 15.8 7.0      | 16.2 7.5        | 18.7 9.8       | 20.4 11.2      | 18.2 11.9      |                |          |  |  |  |  |  |
| Midnight        | 16.0 6.4        | 18.9 9.3       | 12.1 3.8      | 15.6 6.9      | 15.8 7.1        | 17.2 8.3       | 19.7 10.5      | 18.6 12.3      |                |          |  |  |  |  |  |
|                 | 16.7 7.1        | 19.7 10.1      | 12.3 3.8      | 15.7 7.0      | 15.2 6.5        | 16.0 7.1       | 17.1 7.9       | 18.7 12.5      |                |          |  |  |  |  |  |

June 30. Correction +0.6

July 2. " -0.8 before S. A. M., and -8.2 after S. A. M.

" 4. " -8.6

" 6. " -9.2

" 7. " -9.2 Tide register out of order at 2 o'clock, changed index 1 foot; correction after S. The readings appear irregular. Correction at noon -7.0, at midnight -6.2.

July 1. Correction -9.4

" 3. " -8.8

" 5. " -8.8

2 A.M. 10.2.

June 30. Correction — 9.6

July 1. Correction — 9.4

July 2. " — 9.8 before 8 A. M., and — 8.2 after 8 A. M.

" 3. " — 8.8

" 4. " — 8.6

" 5. " — 8.8

" 6. " — 9.2

" 7. " — 9.2 Tide register out of order at 2 o'clock, changed index 1 foot; correction after

" 8. The readings appear irregular. Correction at moon — 7.0, at midnight — 6.2.

[2 A. M. 10.2.]

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

July, 1854.

| Mean<br>solar<br>hour. | 10th.<br>Ref.<br>obs. | 11th.<br>Ref.<br>obs. | 12th.<br>Ref.<br>obs. | 13th.<br>Ref.<br>obs. | 14th.<br>Ref.<br>obs. | 15th.<br>Ref.<br>obs. | 16th.<br>Ref.<br>obs. | 17th.<br>Ref.<br>obs. | 18th.<br>Ref.<br>obs. | 19th.<br>Ref.<br>obs. | 20th.<br>Ref.<br>obs. |
|------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1                      | 18.4 12.3             | 19.3 13.4             | 19.3 13.3             | 19.5 13.5             | 17.0 11.0             | 18.1 ?                | ---                   | ---                   | ---                   | ---                   | 20.8 6.1              |
| 2                      | 16.8 10.7             | 19.0 13.1             | 19.3 13.3             | 19.5 13.6             | 18.0 12.0             | 18.1 "                | ---                   | ---                   | ---                   | ---                   | 20.5 5.8              |
| 3                      | 14.1 8.1              | 17.0 11.0             | 19.0 13.0             | 19.0 13.0             | 18.6 12.6             | 13.2 "                | ---                   | ---                   | ---                   | ---                   | 20.4 5.6              |
| 4                      | 12.5 6.5              | 14.0 8.0              | 16.5 10.5             | 17.8 11.8             | 18.4 12.4             | ---                   | ---                   | ---                   | ---                   | ---                   | 20.4 5.6              |
| 5                      | 10.0 4.0              | 12.1 6.1              | 12.0 6.0              | 16.3 10.3             | 17.3 11.3             | ---                   | ---                   | ---                   | ---                   | ---                   | 20.5 5.7              |
| 6                      | 8.2 2.2               | 9.1 3.1               | 10.1 4.1              | 14.0 8.0              | 15.0 9.0              | ---                   | ---                   | ---                   | ---                   | ---                   | 20.8 5.9              |
| 7                      | 8.2 2.2               | 8.0 2.0               | 7.8 1.8               | 10.2 4.2              | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 20.4 5.5              |
| 8                      | 8.5 2.5               | 7.5 1.5               | 7.1 1.1               | 7.5 1.5               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 19.2 4.7              |
| 9                      | 9.0 3.0               | 7.8 1.8               | 7.0 1.0               | 7.0 1.0               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 19.4 4.8              |
| 10                     | 9.4 ?                 | 8.5 2.5               | 7.3 1.3               | 7.0 1.0               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 21.2 6.3              |
| 11                     | 6.6 ---               | 9.0 3.0               | 8.2 2.2               | 7.0 1.0               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 20.3 5.7              |
| 12                     | 7.2 ---               | 11.5 6.5              | 10.5 4.5              | 8.0 2.0               | 7.8 1.8               | ---                   | ---                   | ---                   | ---                   | ---                   | 22.1 7.2              |
| 13                     | 10.3 4.5              | 14.0 8.0              | 13.0 7.0              | 10.2 4.2              | 7.9 1.9               | ---                   | ---                   | ---                   | ---                   | ---                   | 22.2 7.3              |
| 14                     | 12.1 6.3              | 15.6 9.6              | 15.4 9.4              | 12.6 6.6              | 9.3 3.3               | ---                   | ---                   | ---                   | ---                   | ---                   | 23.0 8.1              |
| 15                     | 13.5 7.7              | 16.0 10.0             | 16.1 10.1             | 11.9 5.9              | 12.3 6.3              | ---                   | ---                   | ---                   | ---                   | ---                   | 23.3 8.4              |
| 16                     | 14.0 8.2              | 16.1 10.1             | 16.0 10.0             | 15.9 9.9              | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.6 8.7              |
| 17                     | 14.2 8.4              | 16.0 10.0             | 16.0 10.0             | 16.0 10.0             | 14.4 8.4              | ---                   | ---                   | ---                   | ---                   | ---                   | 23.5 8.6              |
| 18                     | 13.1 7.5              | 15.0 9.0              | 15.0 9.0              | 15.0 9.0              | 14.4 8.4              | ---                   | ---                   | ---                   | ---                   | ---                   | 23.5 8.6              |
| 19                     | 12.1 6.3              | 15.2 9.2              | 15.3 9.3              | 16.0 10.0             | 15.2 9.2              | ---                   | ---                   | ---                   | ---                   | ---                   | 23.0 8.0              |
| 20                     | 10.2 4.1              | 13.2 7.2              | 13.2 7.2              | 16.2 10.2             | 15.2 9.2              | ---                   | ---                   | ---                   | ---                   | ---                   | 20.1 5.2              |
| 21                     | 8.0 2.0               | 10.0 4.0              | 11.0 5.0              | 13.3 7.3              | 14.3 8.3              | ---                   | ---                   | ---                   | ---                   | ---                   | 19.1 4.5              |
| 22                     | 7.8 2.0               | 8.7 2.7               | 10.0 4.0              | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 19.7 4.8              |
| 23                     | 7.0 1.0               | 7.8 1.8               | 8.0 2.0               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 20.4 5.5              |
| 24                     | 7.0 1.0               | 7.2 1.2               | 7.2 1.2               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 21.2 6.3              |
| 25                     | 7.6 1.6               | 7.2 1.2               | 8.7 2.7               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 22.1 7.2              |
| 26                     | 10.1 4.2              | 7.5 1.5               | 7.2 1.2               | 9.0 3.0               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 22.1 7.2              |
| 27                     | 13.1 7.2              | 9.0 3.0               | 7.5 1.5               | 8.4 2.4               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.4 8.7              |
| 28                     | 15.0 9.1              | 10.5 4.5              | 9.2 3.2               | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.4 8.7              |
| 29                     | 17.0 11.1             | 13.9 7.9              | 12.2 6.2              | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.4 8.7              |
| 30                     | 18.6 12.7             | 16.8 10.8             | 16.8 10.8             | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.4 8.7              |
| 31                     | 19.0 13.1             | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 23.4 8.7              |
| Mean                   | 19.5 13.6             | 19.0 13.0             | 18.2 12.2             | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | ---                   | 20.3 5.9              |

July 10. Correction — 5.8

" 12. " — 6.0

" 14. " — 6.0

" 18. " — 14.3

" 20. " — 14.9

July 11. Correction — 6.0

" 13. " — 6.0

" 15. " ?

" 19. " — 14.6

—9.4

—8.8

—8.8

correction after  
12 A.M. 10.2.

## SERIES III.—TIDAL OBSERVATIONS FROM APRIL 20 TO AUGUST 3, 1854.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

| Mean solar hour. | July, 1854.                                    |           |      |           |      |           | August, 1854. |           |      |           |      |           |
|------------------|------------------------------------------------|-----------|------|-----------|------|-----------|---------------|-----------|------|-----------|------|-----------|
|                  | 28th                                           | Ref. obs. | 29th | Ref. obs. | 30th | Ref. obs. | 31st          | Ref. obs. | 1st  | Ref. obs. | 2d   | Ref. obs. |
| 1                | Correction to readings not sufficiently known. |           | 10.6 | 10.1      | 10.6 | 10.5      | 8.3           | 8.3       | 8.0  | 8.0       | 6.8  | 7.0       |
| 2                |                                                |           | 11.3 | 10.8      | 11.2 | 11.1      | 8.6           | 8.6       | 8.4  | 8.4       | 8.0  | 8.2       |
| 3                |                                                |           | 12.3 | 11.8      | 11.2 | 11.1      |               |           | 9.1  | 9.1       |      |           |
| 4                |                                                |           | 12.5 | 12.0      | 11.2 | 11.1      | 9.3           | 9.3       | 9.3  | 9.3       | 8.7  | 8.9       |
| 5                |                                                |           | 11.3 | 10.8      | 11.0 | 11.0      |               |           |      |           | 9.0  | 9.3       |
| 6                |                                                |           | 10.2 | 9.7       | 10.8 | 10.8      | 10.6          | 10.6      | 9.3  | 9.3       | 9.0  | 9.3       |
| 7                |                                                |           |      |           |      |           |               |           | 9.2  | 9.2       |      |           |
| 8                |                                                |           | 8.4  | 8.0       | 10.2 | 10.2      | ...           | ...       | 9.0  | 9.0       | 10.2 | 10.5      |
| 9                |                                                |           | 6.1  | 5.7       | 8.5  | 8.5       | ...           | ...       | 9.0  | 9.0       |      |           |
| 10               |                                                |           |      |           |      |           |               |           | 9.0  | 9.0       | 9.1  | 9.4       |
| 11               |                                                |           |      |           |      |           |               |           |      |           |      |           |
| 12               |                                                |           |      |           |      |           |               |           |      |           |      |           |
| 1                |                                                | 7.6       | 7.2  | 6.9       | 6.1  | 6.1       | 6.2           | 6.2       | 4.4  | 4.4       | 4.1  | 4.5       |
| 2                |                                                | 8.4       |      |           |      |           |               |           | 4.4  | 4.4       | 4.1  | 4.5       |
| 3                |                                                | 8.5       | 9.2  | 8.9       | 7.9  | 7.9       | 7.5           | 7.5       | 5.0  | 5.0       | 4.3  | 4.7       |
| 4                |                                                | 8.6       |      |           |      |           | 8.0           | 8.0       | 5.7  | 5.7       | 4.8  | 5.2       |
| 5                |                                                | 8.6       | 10.2 | 9.9       | 8.3  | 8.3       | 9.0           | 9.0       | 7.0  | 7.0       | 5.9  | 6.3       |
| 6                |                                                | 8.6       |      |           | 8.5  | 8.5       | 9.0           | 9.0       |      |           |      |           |
| 7                |                                                | 8.5       | 11.3 | 10.0      | 9.2  | 9.2       | 9.0           | 9.0       | 8.7  | 8.7       | 6.4  | 6.8       |
| 8                |                                                | 8.5       | 11.4 | 11.2      | 9.0  | 9.0       | 9.0           | 9.0       | 9.5  | 9.5       |      |           |
| 9                |                                                |           | 11.3 | 11.3      | 8.3  | 8.3       | 9.0           | 9.0       | 10.4 | 10.5      | 6.8  | 7.2       |
| 10               |                                                | 6.8       | 11.0 | 10.8      |      |           |               |           | 10.4 | 10.5      |      |           |
| 11               |                                                | 4.9       | 10.0 | 9.8       | 7.2  | 7.2       | 9.1           | 9.1       | 10.4 | 10.5      | 7.0  | 7.4       |
| 12               |                                                |           |      |           |      |           |               |           | 10.4 | 10.5      | 8.2  | 8.6       |
| 1                |                                                | 3.1       | 7.8  | 7.6       | 6.0  | 6.0       | 8.0           | 8.0       | 10.2 | 10.3      | 9.1  | 9.5       |
| 2                |                                                | 2.3       | 4.2  | 4.1       | 5.1  | 5.1       | 6.6           | 6.6       | 9.0  | 9.1       | 9.0  | 9.4       |
| 3                |                                                | 2.1       |      |           | 4.3  | 4.3       |               |           |      |           |      |           |
| 4                |                                                | 2.0       | 3.4  | 3.3       | 4.1  | 4.1       | 5.1           | 5.4       | 7.4  | 7.5       | 9.0  | 9.4       |
| 5                |                                                | 2.4       |      |           | 4.1  | 4.1       | 4.8           | 4.8       |      |           |      |           |
| 6                |                                                | 2.7       | 3.3  | 3.2       | 4.1  | 4.1       | 4.8           | 4.8       | 6.2  | 6.1       | 7.4  | 7.8       |
| 7                |                                                | 2.7       | 4.0  | 3.9       | 5.0  | 5.0       | 4.8           | 4.8       | 6.0  | 6.1       |      |           |
| 8                |                                                | 4.9       | 4.0  | 3.9       | 5.2  | 5.2       | 4.8           | 4.8       | 6.0  | 6.1       | 6.2  | 6.6       |
| 9                |                                                | 4.9       |      |           |      |           | 4.8           | 4.8       | 6.0  | 6.1       |      |           |
| 10               |                                                | 5.9       | 6.0  | 5.9       | 6.4  | 6.4       | 4.8           | 4.8       | 6.2  | 6.1       | 5.8  | 6.2       |
| 11               |                                                |           |      |           |      |           | 5.1           | 5.1       |      |           |      |           |
| 12               |                                                | 8.5       | 8.0  | 7.9       | ...  | ...       | 5.6           | 5.6       | 6.5  | 6.7       | 5.6  | 6.0       |

Between the 29th and 27th of July the observations do not appear sufficiently regular to promise any reliable results.

July 28, Correction -0.7

July 29, Correction -0.3

July 30, Correction 0.0

Aug. 1, " 0.0

Aug. 2, " -0.0

Aug. 3, " +0.4

Aug. 3, " +0.4. After this date the observations are irregular.

On the 5th the rope slipped off the wheel.

Aug. 8. The brig was released from the ice cradle at 10 A. M., rising suddenly 21 feet. She resumed this position upon very slight disturbance of the external ice, and is now on an even keel for the first time in eleven months. The brig was frozen in and fast since the 9th of September, 1853.

Aug. 10. The high-water mark was cut on the island by Mr. McGary.

Aug. 11. The warping of the ships was commenced. Tidal observations were resumed on the 12th. The register is kept in fathoms and feet.

# RECORD AND REDUCTION OF THE TIDES

39

## SERIES IV.—TIDAL OBSERVATIONS FROM SEPTEMBER 7 TO OCTOBER 22, 1851.

Hourly observations on the pulley-gauge. Adopted reading of mean level 7.0, expressed in units of the scale. Increasing numbers indicate rise of water.

### September, 1854.

| Mean solar hour. | 7th. | 8th. | 9th. | 10th. | 11th. | 12th. | 13th. | 14th. | 15th. | 16th. | 17th. | 18th. | 19th. | 20th. | 21st. | 22d. | 23d. | 24th. | 25th. | 26th. | 27th. |
|------------------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|-------|-------|-------|-------|
| 1                | 100  | 135  | 130  | 100   | 100   | 80    | 60    | 50    | 50    | 70    | 90    | 90    | 100   | 112   | 120   | 110  | 130  | 130   | 100   |       |       |
| 2                | 50   | 135  | 110  | 110   | 140   | 90    | 70    | 50    | 50    | 60    | 80    | 75    | 80    | 90    | 100   | 100  | 140  | 110   | 120   |       |       |
| 3                | 20   | 110  | 70   | 110   | 110   | 100   | 40    | 50    | 60    | 70    | 50    | 50    | 40    | 70    | 80    | 100  | 100  | 100   | 100   |       |       |
| 4                | 10   | 70   | 47   | 90    | 90    | 90    | 30    | 50    | 50    | 50    | 30    | 50    | 30    | 30    | 60    | 70   | 80   | 80    | 80    |       |       |
| 5                | 17   | 50   | 30   | 70    | 60    | 60    | 40    | 50    | 50    | 60    | 50    | 20    | 40    | 20    | 0     | 35   | 40   | 60    | 40    |       |       |
| 6                | 17   | 30   | 10   | 50    | 40    | 40    | 50    | 50    | 90    | 70    | 70    | 40    | 50    | 30    | 0     | 7    | 30   | 30    | 20    |       |       |
| 7                | 10   | 22   | 10   | 30    | 20    | 60    | 60    | 50    | 90    | 90    | 80    | 60    | 60    | 50    | 20    | 20   | 20   | 0     | 0     |       |       |
| 8                | 0    | 10   | 10   | 0     | 0     | 10    | 80    | 50    | 90    | 85    | 100   | 70    | 70    | 60    | 40    | 20   | 0    | 10    | 10    |       |       |
| 9                | 20   | 40   | 0    | 0     | 0     | 10    | 20    | 0     | 80    | 75    | 100   | 80    | 85    | 80    | 70    | 50   | 10   | 30    | 10    |       |       |
| 10               | 0    | 0    | 0    | 40    | 20    | 30    | 30    | 100   | 60    | 90    | 95    | 90    | 100   | 100   | 100   | 100  | 30   | 40    | 30    |       |       |
| 11               | 140  | 65   | 40   | 40    | 50    | 40    | 40    | 50    | 70    | 85    | 95    | 115   | 125   | 110   | 120   | 60   | 70   | 60    |       |       |       |
| Nonon            | 120  | 110  | 70   | 70    | 60    | 40    | 50    | 65    | 80    | 100   | 130   | 130   | 130   | 125   | 100   | 90   |      |       |       |       |       |
| 1                | 110  | 140  | 90   | 90    | 50    | 80    | 50    | 50    | 60    | 75    | 90    | 100   | 110   | 120   | 130   | 120  | 100  |       |       |       |       |
| 2                | 100  | 100  | 110  | 100   | 40    | 90    | 70    | 60    | 55    | 70    | 60    | 80    | 100   | 100   | 120   | 130  | 120  |       |       |       |       |
| 3                | 80   | 70   | 90   | 80    | 90    | 90    | 80    | 70    | 50    | 67    | 40    | 60    | 60    | 70    | 90    | 110  | 110  | 140   |       |       |       |
| 4                | 60   | 40   | 60   | 50    | 100   | 90    | 90    | 80    | 70    | 65    | 20    | 10    | 30    | 50    | 60    | 70   | 90   | 100   |       |       |       |
| 5                | 40   | 20   | 100  | 80    | 90    | 90    | 80    | 90    | 80    | 60    | 30    | 15    | 10    | 10    | 30    | 60   | 60   | 90    |       |       |       |
| 6                | 20   | 60   | 105  | 40    | 60    | 70    | 100   | 90    | 50    | 40    | 30    | 20    | 0     | 0     | 10    | 20   | 40   | 40    | 70    |       |       |
| 7                | 10   | 0    | 90   | 10    | 40    | 40    | 80    | 100   | 100   | 80    | 60    | 40    | 30    | 0     | 10    | 20   | 80   | 30    |       |       |       |
| 8                | 0    | 0    | 50   | 50    | 60    | 30    | 90    | 104   | 105   | 110   | 80    | 70    | 50    | 40    | 20    | 60   | 60   | 0     |       |       |       |
| 9                | 110  | 50   | 40   | 20    | 15    | 15    | 40    | 100   | 100   | 105   | 115   | 100   | 95    | 75    | 50    | 50   | 10   | 10    |       |       |       |
| 10               | 130  | 80   | 60   | 10    | 30    | 30    | 50    | 90    | 100   | 120   | 120   | 120   | 115   | 100   | 80    | 40   | 40   |       |       |       |       |
| 11               | 145  | 110  | 100  | 70    | 70    | 50    | 50    | 80    | 104   | 110   | 120   | 130   | 140   | 100   | 90    | 110  | 70   | 60    |       |       |       |
| Midnight         | 142  | 130  | 120  | 100   | 80    | 70    | 70    | 65    | 90    | 100   | 110   | 110   | 130   | 90    | 100   | 120  | 120  | 130   |       |       |       |

Observations irregular.

### Sept. 1854.

| Mean solar hour. | 28th. | 29th. | 30th. |
|------------------|-------|-------|-------|
| 1                | 90    | 80    | 50    |
| 2                | 120   | 100   | 80    |
| 3                | 130   | 90    | 80    |
| 4                | 100   | 80    | 90    |
| 5                | 90    | 80    | 80    |
| 6                | 55    | 70    | 50    |
| 7                | 30    | 60    | 60    |
| 8                | 10    | 40    | 50    |
| 9                | 30    | 30    | 50    |
| 10               | 30    | 20    | 40    |
| 11               | 90    | 60    | 40    |
| Nonon            | 120   | 70    | 60    |
| 1                | 100   | 90    | 70    |
| 2                | 110   | 100   | 80    |
| 3                | 120   | 115   | 90    |
| 4                | 120   | 115   | 90    |
| 5                | 100   | 110   | 100   |
| 6                | 80    | 110   | 100   |
| 7                | 60    | 90    | 90    |
| 8                | 40    | 60    | 80    |
| 9                | 20    | 30    | 70    |
| 10               | 30    | 40    | 55    |
| 11               | 50    | 55    | 50    |
| Mean             | 60    | 55    | 45    |

Sundays irregular.

### October, 1854.

| Mean solar hour. | 1st. | 2d. | 3d. | 4th. | 5th. | 6th. | 7th. | 8th. | 9th. | 10th. | 11th. | 12th. | 13th. | 14th. | 15th. | 16th. | 17th. | 18th. | 19th. | 20th. | 21st. | 22d. |
|------------------|------|-----|-----|------|------|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| 1                | 90   | 80  | 50  | 60   | 100  | 120  | 110  | 80   | 130  | 100   | 85    | 60    | 50    | 50    | 60    | 50    | 50    | 50    | 50    | 50    | 50    | 50   |
| 2                | 120  | 100 | 80  | 40   | 70   | 100  | 120  | 70   | 120  | 100   | 115   | 70    | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40    | 40   |
| 3                | 130  | 90  | 80  | 60   | 0    | 50   | 70   | 70   | 40   | 100   | 90    | 100   | 80    | 30    | 30    | 10    | 30    | 05    | 10    | 05    | 10    | 05   |
| 4                | 100  | 80  | 90  | 12   | 30   | 40   | 50   | 20   | 70   | 80    | 70    | 100   | 40    | 40    | 00    | 20    | 00    | 00    | 00    | 00    | 00    | 00   |
| 5                | 90   | 80  | 80  | 10   | 10   | 20   | 20   | 10   | 40   | 50    | 90    | 50    | 60    | 20    | 10    | 10    | 05    | 10    | 05    | 10    | 05    | 10   |
| 6                | 55   | 70  | 50  | 0    | 0    | 10   | 10   | 00   | 00   | 20    | 40    | 80    | 60    | 30    | 30    | 20    | 15    | 10    | 15    | 10    | 15    | 10   |
| 7                | 30   | 60  | 60  | 40   | 40   | 40   | 10   | 00   | 00   | 10    | 10    | 30    | 70    | 70    | 60    | 50    | 30    | 30    | 30    | 30    | 30    | 30   |
| 8                | 10   | 40  | 50  | 50   | 70   | 70   | 50   | 10   | 05   | 15    | 00    | 20    | 60    | 80    | 90    | 90    | 70    | 60    | 60    | 60    | 60    | 60   |
| 9                | 30   | 30  | 50  | 100  | 100  | 100  | 85   | 70   | 70   | 25    | 20    | 35    | 50    | 110   | 120   | 100   | 80    | 70    | 70    | 70    | 70    | 70   |
| 10               | 30   | 20  | 40  | 100  | 110  | 115  | 115  | 90   | 100  | 50    | 55    | 50    | 40    | 100   | 100   | 115   | 110   | 110   | 110   | 110   | 110   | 110  |
| 11               | 90   | 60  | 40  | 80   | 120  | 120  | 115  | 112  | 100  | 70    | 110   | 60    | 30    | 80    | 80    | 100   | 120   | 120   | 120   | 120   | 120   | 120  |
| Nonon            | 120  | 70  | 60  | 80   | 130  | 120  | 140  | 130  | 120  | 100   | 130   | 80    | 10    | 60    | 70    | 80    | 100   | 120   | 120   | 120   | 120   | 120  |
| 1                | 120  | 70  | 60  | 60   | 70   | 120  | 130  | 120  | 140  | 130   | 130   | 50    | 40    | 50    | 60    | 75    | 80    | 100   | 100   | 100   | 100   | 100  |
| 2                | 100  | 90  | 70  | 0    | 40   | 85   | 90   | 120  | 140  | 140   | 130   | 130   | 50    | 40    | 50    | 40    | 30    | 40    | 30    | 30    | 30    | 30   |
| 3                | 110  | 100 | 80  | 20   | 20   | 70   | 50   | 80   | 90   | 125   | 120   | 140   | 60    | 30    | 20    | 10    | 05    | 40    | 40    | 40    | 40    | 40   |
| 4                | 120  | 115 | 90  | 00   | 00   | 30   | 30   | 30   | 70   | 90    | 100   | 140   | 70    | 40    | 20    | 10    | 00    | 20    | 15    | 15    | 15    | 15   |
| 5                | 100  | 110 | 100 | 00   | 20   | 10   | 00   | 20   | 50   | 80    | 70    | 110   | 80    | 50    | 30    | 20    | 10    | 00    | 00    | 00    | 00    | 00   |
| 6                | 80   | 110 | 100 | 50   | 30   | 00   | 00   | 10   | 30   | 40    | 40    | 90    | 90    | 70    | 40    | 60    | 30    | 10    | 10    | 10    | 10    | 10   |
| 7                | 60   | 90  | 90  | 00   | 00   | 00   | 00   | 00   | 10   | 20    | 30    | 74    | 90    | 70    | 70    | 70    | 40    | 10    | 30    | 30    | 30    | 30   |
| 8                | 40   | 60  | 80  | 100  | 90   | 00   | 50   | 10   | 00   | 05    | 20    | 60    | 100   | 70    | 95    | 80    | 70    | 30    | 70    | 70    | 70    | 70   |
| 9                | 20   | 30  | 70  | 100  | 130  | 90   | 70   | 40   | 30   | 30    | 30    | 40    | 80    | 80    | 120   | 90    | 80    | 70    | 100   | 100   | 100   | 100  |
| 10               | 30   | 40  | 55  | 130  | 132  | 120  | 100  | 60   | 55   | 40    | 40    | 60    | 60    | 110   | 100   | 100   | 90    | 100   | 100   | 100   | 100   | 100  |
| 11               | 50   | 55  | 50  | 140  | 140  | 140  | 135  | 90   | 80   | 70    | 70    | 80    | 50    | 80    | 70    | 100   | 90    | 120   | 120   | 120   | 120   | 120  |
| Mean             | 60   | 55  | 45  | 130  | 110  | 135  | 140  | 100  | 110  | 100   | 100   | 100   | 70    | 70    | 60    | 110   | 110   | 110   | 110   | 110   | 110   | 110  |

NOTE.—The above numbers were taken from the record, converting the fathoms into feet and deducting 8, in order to reduce the mean level of 15 feet to the adopted level of comparison of 7 feet. The observations are taken with the sounding line, bottom nearly.

Sept. 8. Some doubt about the time between 1 and 5 P. M.  
After October 22 the soundings are too irregular, and later observations with the pulley-gauge too much affected by changes of the index.

This last series is considerably inferior in accuracy to the three preceding series.

*Reduction of Tides, Van Rensselaer Harbor, 1853-54.*

Having given the tidal record in a form ready for use, the observations next require to be properly tabulated for the purpose of deducing empirically their laws, and for comparison with theory. In the United States Coast Survey two blank forms are in use for this tabulation; they have in their essential part been adopted as suitable for the Van Rensselaer Harbor tides, and were used with permission of the Superintendent of the Survey. They are strictly applicable only for such cases where the diurnal inequality is comparatively small, or is at least not approximating to the production of single day tides. In order to show, at a glance, the general character of the tides under discussion, they were plotted a second time, and are given in Plates I, II, and III; the observations having previously been referred to the same mean level. From these diagrams it appears that the diurnal inequality is not of so great an effect as to render the use of the ordinary method of reduction unavailable; on the other hand, it is sufficiently large to require a special discussion for time and height. The extension of the series of observations over a whole year must be considered as a fortunate circumstance, since the results thereby gain considerably in accuracy over others deduced only from a few disconnected lunations.

The tidal record would not be complete without the observations for direction and force of the wind, and for atmospheric pressure; the reader will find these records in my discussion of the meteorological material of the expedition, in Vol. XI, Smithsonian Contributions to Knowledge, 1859.

The following pages contain the first tabulation of the preceding record, viz: column 1 contains the date, civil reckoning, adopted for convenience sake. Column 2 gives the apparent time (civil reckoning) of the moon's superior and inferior transit over the Van Rensselaer meridian, obtained by adding nine minutes to the time of transit at Greenwich, allowing for a difference of longitude of  $4^{\text{h}} 43^{\text{m}} \text{ W.}$  The mean time was converted into apparent time by applying the equation of time. The time for the lower transit was obtained by taking the mean of the time of the preceding and following upper transit. Columns 3 and 4 contain the apparent time of high and low water, taken from the record; in some cases a graphical method was resorted to, to obtain the instant of these phases with greater precision. The equation of time has been applied to the mean time in which the observations are expressed. Columns 5 and 6 contain the lunitidal interval between the time of high water and low water, and the time of the transit of the moon immediately preceding, though in some cases, owing to the half-monthly inequality, it may be the second preceding, the establishment being about  $11\frac{1}{2}$  hours. This transit of comparison has been called transit *F* by Mr. Lubbock.<sup>1</sup> The next columns, 7 and 8, give the height of high and low water, extracted from the preceding abstract. The remaining columns contain the moon's parallax and declination at noon.

<sup>1</sup> See an Elementary Treatise on the Tides, by J. W. Lubbock, Esq., London, 1839.

TABLE FOR THE REDUCTION OF TIDES.—No. 1.

Showing the times of High and Low Water, and the Heights of High and Low Tides; together with the time of the Moon's passing the Meridian of the place, and the Lunital intervals, at Van Rensselaer Harbor during the months of October 10, 1853, to October 22, 1855.

## SERIES I.—FROM OCTOBER 10 TO DECEMBER 28, 1853.

| DATE.<br>1853. | Moon passes the meridian. |     | Apparent time of    |     |     |     | Lunital interval.   |     |     |     | Height of           |      |     |      | Moon's parallax at noon. |      | Moon's declination at noon. |      |
|----------------|---------------------------|-----|---------------------|-----|-----|-----|---------------------|-----|-----|-----|---------------------|------|-----|------|--------------------------|------|-----------------------------|------|
|                | Appar. time.              |     | H. water. L. water. |     |     |     | H. water. L. water. |     |     |     | H. water. L. water. |      |     |      | Min. Dec.                |      | Degree. Dec.                |      |
|                | H.                        | M.  | H.                  | M.  | H.  | M.  | H.                  | M.  | H.  | M.  | Fe.                 | Dec. | Fe. | Dec. | Min.                     | Dec. | Degree.                     | Dec. |
| Oct. 9         | 6                         | 28  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 10           | 6                         | 57  | 8                   | 13  | 11  | 13  | 13                  | 45  | 16  | 45  | 8                   | 0    | 4   | 7    | 58                       | 4    | -23                         | 8    |
| " 11           | 7                         | 26  | 6                   | 13  | ... | ... | 11                  | 16  | ... | ... | 9                   | 2    | ... | ...  | 57                       | 8    | -20                         | 9    |
| " 12           | 8                         | 22  | 7                   | 43  | 1   | 13  | 11                  | 49  | 17  | 47  | 9                   | 5    | 4   | 8    | 57                       | 3    | -17                         | 0    |
| " 13           | 9                         | 47  | 8                   | 13  | 1   | 43  | 11                  | 51  | 17  | 49  | 7                   | 9    | 4   | 0    | 57                       | 3    | -17                         | 0    |
| " 14           | 9                         | 12  | 9                   | 29  | 2   | 43  | 12                  | 42  | 18  | 21  | 10                  | 0    | 4   | 2    | 56                       | 7    | -12                         | 3    |
| " 15           | 9                         | 37  | 9                   | 59  | 3   | 14  | 12                  | 47  | 18  | 27  | 9                   | 1    | 3   | 7    | 56                       | 7    | -12                         | 3    |
| " 16           | 10                        | 02  | 10                  | 14  | 3   | 29  | 13                  | 37  | 18  | 47  | 10                  | 9    | 3   | 1    | 56                       | 3    | -7                          | 1    |
| " 17           | 10                        | 24  | 10                  | 14  | 4   | 14  | 12                  | 12  | 18  | 37  | 9                   | 8    | 2   | 7    | 56                       | 3    | -7                          | 1    |
| " 18           | 10                        | 47  | 10                  | 44  | 3   | 59  | 12                  | 20  | 17  | 57  | 11                  | 3    | 2   | 7    | 54                       | 9    | +8                          | 9    |
| " 19           | 0                         | 13  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | 54                       | 9    | +8                          | 9    |
| " 20           | 0                         | 35  | 11                  | 45  | 5   | 15  | 11                  | 10  | 17  | 02  | 10                  | 7    | 1   | 5    | 54                       | 5    | +13                         | 7    |
| " 21           | 0                         | 57  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 22           | 1                         | 18  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | 54                       | 5    | +13                         | 7    |
| " 23           | 1                         | 40  | 0                   | 30  | 6   | 45  | 11                  | 12  | 17  | 27  | 11                  | 5    | 1   | 6    | 54                       | 3    | +17                         | 9    |
| " 24           | 2                         | 02  | 1                   | 15  | 7   | 15  | 11                  | 35  | 17  | 35  | 12                  | 4    | 1   | 9    | 54                       | 3    | +17                         | 9    |
| " 25           | 2                         | 25  | 1                   | 15  | 5   | 45  | 11                  | 13  | 15  | 43  | 11                  | 5    | 5   | 7    | 54                       | 2    | +21                         | 3    |
| " 26           | 2                         | 48  | 1                   | 45  | 9   | 00  | 11                  | 20  | 18  | 35  | 11                  | 9    | 2   | 7    | 54                       | 1    | +24                         | 8    |
| " 27           | 3                         | 12  | 1                   | 30  | 7   | 45  | 10                  | 42  | 16  | 57  | 9                   | 9    | 2   | 8    | 54                       | 1    | +24                         | 8    |
| " 28           | 3                         | 36  | 3                   | 15  | 8   | 30  | 12                  | 03  | 17  | 18  | 11                  | 1    | 4   | 4    | 54                       | 2    | +25                         | 2    |
| " 29           | 4                         | 00  | 1                   | 15  | 9   | 15  | 9                   | 39  | 17  | 40  | 10                  | 5    | 3   | 4    | 54                       | 2    | +25                         | 2    |
| " 30           | 4                         | 25  | 3                   | 16  | 8   | 46  | 11                  | 16  | 16  | 46  | 9                   | 9    | 4   | 5    | 54                       | 4    | +25                         | 5    |
| " 31           | 4                         | 51  | 3                   | 16  | 8   | 31  | 10                  | 51  | 16  | 06  | 10                  | 3    | 3   | 9    | 54                       | 4    | +25                         | 5    |
| " 1            | 5                         | 16  | 4                   | 16  | 10  | 16  | 11                  | 25  | 17  | 25  | 10                  | 4    | 5   | 2    | 54                       | 8    | +24                         | 7    |
| " 2            | 5                         | 42  | 3                   | 31  | 8   | 31  | 10                  | 15  | 15  | 15  | 8                   | 7    | 4   | 5    | 54                       | 8    | +24                         | 7    |
| " 3            | 6                         | 07  | 5                   | 46  | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 4            | 6                         | 32  | 5                   | 01  | 0   | 16  | 10                  | 54  | 18  | 34  | 7                   | 1    | 5   | 4    | 55                       | 4    | +22                         | 6    |
| " 5            | 6                         | 57  | 8                   | 16  | 10  | 46  | 13                  | 44  | 16  | 39  | 8                   | 5    | 5   | 2    | 56                       | 1    | +19                         | 5    |
| " 6            | 7                         | 22  | 7                   | 46  | 0   | 31  | 12                  | 40  | 17  | 59  | 7                   | 0    | 5   | 2    | 56                       | 1    | +19                         | 5    |
| " 7            | 7                         | 46  | 8                   | 46  | 0   | 46  | 13                  | 24  | 17  | 49  | 9                   | 2    | 6   | 1    | 57                       | 0    | +15                         | 3    |
| " 8            | 8                         | 11  | 8                   | 16  | 1   | 46  | 12                  | 30  | 18  | 24  | 8                   | 1    | 4   | 8    | 57                       | 0    | +15                         | 3    |
| " 9            | 8                         | 35  | 8                   | 46  | 0   | 46  | 12                  | 35  | 17  | 00  | 9                   | 8    | 5   | 5    | 57                       | 9    | +10                         | 3    |
| " 10           | 8                         | 59  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 11           | 9                         | 23  | 9                   | 46  | 3   | 46  | 12                  | 47  | 19  | 11  | 10                  | 8    | 5   | 1    | 58                       | 8    | +4                          | 6    |
| " 12           | 9                         | 47  | 9                   | 46  | 4   | 01  | 12                  | 23  | 19  | 02  | 10                  | 7    | 3   | 4    | 59                       | 7    | -1                          | 5    |
| " 13           | 10                        | 11  | 10                  | 46  | 4   | 16  | 12                  | 59  | 18  | 53  | 11                  | 4    | 4   | 9    | 59                       | 7    | -1                          | 5    |
| " 14           | 10                        | 36  | 12                  | 01  | 3   | 46  | 13                  | 50  | 17  | 59  | 11                  | 6    | 2   | 9    | 60                       | 4    | -7                          | 7    |
| " 15           | 11                        | 01  | 10                  | 46  | 5   | 16  | 12                  | 10  | 19  | 05  | 11                  | 7    | 3   | 9    | 60                       | 4    | -7                          | 7    |
| " 16           | 11                        | 26  | 11                  | 31  | 4   | 16  | 12                  | 30  | 17  | 40  | 12                  | 0    | 1   | 6    | 60                       | 8    | -13                         | 6    |
| " 17           | 11                        | 52  | 12                  | 16  | 5   | 01  | 12                  | 50  | 18  | 00  | 12                  | 2    | 1   | 9    | 60                       | 8    | -13                         | 6    |
| " 18           | ...                       | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 19           | 0                         | 19  | 11                  | 16  | 7   | 01  | 10                  | 57  | 19  | 09  | 11                  | 6    | 3   | 6    | 61                       | 0    | -18                         | 7    |
| " 20           | 0                         | 48  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 21           | 1                         | 16  | 0                   | 16  | 7   | 16  | 11                  | 28  | 18  | 28  | 14                  | 3    | 0   | 1    | 60                       | 9    | -22                         | 7    |
| " 22           | 1                         | 46  | 1                   | 16  | 7   | 16  | 12                  | 00  | 18  | 00  | 11                  | 8    | 0   | 0    | 60                       | 9    | -22                         | 7    |
| " 23           | 2                         | 16  | 1                   | 31  | 8   | 46  | 11                  | 45  | 19  | 00  | 14                  | 2    | 1   | 5    | 60                       | 5    | -25                         | 0    |
| " 24           | 2                         | 47  | 1                   | 16  | 8   | 01  | 11                  | 00  | 17  | 45  | 11                  | 6    | 0   | 3    | 60                       | 5    | -25                         | 0    |
| " 25           | 3                         | 19  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |
| " 26           | 3                         | 50  | 1                   | 16  | 8   | 31  | 9                   | 57  | 17  | 12  | 10                  | 1    | 0   | 7    | 59                       | 9    | -25                         | 6    |
| " 27           | 4                         | 22  | 2                   | 46  | 8   | 46  | 10                  | 56  | 16  | 56  | 13                  | 0    | 1   | 8    | 59                       | 1    | -24                         | 5    |
| " 28           | 4                         | 52  | 4                   | 01  | 9   | 01  | 11                  | 39  | 16  | 39  | 9                   | 1    | 2   | 3    | 59                       | 1    | -24                         | 5    |
| " 29           | 5                         | 23  | 4                   | 46  | 10  | 31  | 11                  | 54  | 17  | 39  | 10                  | 9    | 2   | 6    | 58                       | 4    | -21                         | 9    |
| " 30           | 5                         | 52  | 3                   | 46  | 10  | 16  | 10                  | 23  | 16  | 53  | 8                   | 2    | 2   | 2    | 58                       | 4    | -21                         | 9    |
| " 31           | 6                         | 21  | 4                   | 31  | ... | ... | ...                 | ... | ... | ... | ...                 | ...  | ... | ...  | ...                      | ...  | ...                         | ...  |



## SERIES L.—FROM OCTOBER 10 TO DECEMBER 28, 1853.

| SERIES I.—FROM OCTOBER 10 TO DECEMBER 28, 1853. |                              |     |                  |    |           |     |                   |    |           |     |           |      |           |      |                                |      |                                   |      |
|-------------------------------------------------|------------------------------|-----|------------------|----|-----------|-----|-------------------|----|-----------|-----|-----------|------|-----------|------|--------------------------------|------|-----------------------------------|------|
| DATE<br>1853                                    | Moon passes<br>the meridian. |     | Apparent time of |    |           |     | Lunital interval. |    |           |     | Height of |      |           |      | Moon's<br>parallax<br>at noon. |      | Moon's<br>declination<br>at noon. |      |
|                                                 | Appar. time                  |     | H. water.        |    | L. water. |     | H. water.         |    | L. water. |     | L. water. |      | H. water. |      | Min.                           | Sec. | Degree.                           | Dec. |
|                                                 | H.                           | M.  | H.               | M. | H.        | M.  | H.                | M. | H.        | M.  | Fe.       | Dec. | Fe.       | Dec. |                                |      |                                   |      |
| Nov. 8                                          | 0                            | 48  | 5                | 16 | 0         | 16  | 10                | 55 | 18        | 24  | 7         | 8    | 3         | 5    | 57                             | 6    | -18                               | 1    |
| " 9                                             | 7                            | 14  | 6                | 46 | 0         | 16  | 11                | 55 | 17        | 50  | 10        | 4    | 4         | 9    | 56                             | 9    | -13                               | 5    |
| " 10                                            | 8                            | 02  | 7                | 31 | 1         | 16  | 11                | 53 | 18        | 02  | 11        | 0    | 4         | 4    | 56                             | 3    | -8                                | 4    |
| " 11                                            | 9                            | 09  | 8                | 46 | 0         | 46  | 12                | 44 | 17        | 08  | 9         | 8    | 4         | 3    | 55                             | 7    | -3                                | 1    |
| " 12                                            | 9                            | 52  | 10               | 01 | 4         | 16  | 12                | 30 | 19        | 07  | 11        | 2    | 2         | 2    | 55                             | 2    | +2                                | 3    |
| " 13                                            | 10                           | 13  | 9                | 46 | 3         | 31  | 11                | 54 | 18        | 00  | 11        | 5    | 3         | 8    | 54                             | 8    | +7                                | 5    |
| " 14                                            | 10                           | 34  | 10               | 16 | 4         | 46  | 12                | 03 | 18        | 54  | 11        | 5    | 2         | 6    | 54                             | 5    | +12                               | 4    |
| " 15                                            | 11                           | 15  | 10               | 45 | 5         | 0   | 10                | 51 | 18        | 26  | 12        | 7    | 2         | 1    | 54                             | 2    | +16                               | 8    |
| " 16                                            | 11                           | 37  | 10               | 45 | 5         | 30  | 11                | 53 | 18        | 36  | 9         | 8    | 2         | 0    | 54                             | 2    | +16                               | 8    |
| " 17                                            | 0                            | 21  | 12               | 00 | 6         | 30  | 12                | 01 | 18        | 53  | 13        | 0    | 3         | 5    | 54                             | 1    | +20                               | 5    |
| " 18                                            | 0                            | 44  | 11               | 15 | 7         | 15  | 11                | 01 | 18        | 54  | 10        | 9    | 3         | 1    | 54                             | 0    | +23                               | 2    |
| " 19                                            | 1                            | 07  | 10               | 30 | 6         | 45  | 11                | 23 | 17        | 38  | 13        | 0    | 3         | 1    | 54                             | 0    | +25                               | 0    |
| " 20                                            | 1                            | 29  | 1                | 15 | 8         | 15  | 11                | 20 | 18        | 20  | 12        | 1    | 1         | 2    | 54                             | 1    | +25                               | 0    |
| " 21                                            | 2                            | 41  | 1                | 14 | 8         | 14  | 11                | 00 | 17        | 39  | 13        | 0    | 2         | 3    | 54                             | 1    | +25                               | 7    |
| " 22                                            | 3                            | 03  | 1                | 44 | 8         | 14  | 10                | 55 | 17        | 05  | 9         | 1    | 2         | 6    | 54                             | 4    | +25                               | 2    |
| " 23                                            | 3                            | 25  | 2                | 14 | 8         | 29  | 10                | 40 | 17        | 25  | 11        | 5    | 3         | 6    | 54                             | 7    | +23                               | 5    |
| " 24                                            | 4                            | 46  | 2                | 43 | 7         | 39  | 10                | 30 | 16        | 06  | 8         | 0    | 3         | 2    | 55                             | 3    | +20                               | 7    |
| " 25                                            | 5                            | 11  | 2                | 49 | 8         | 14  | 10                | 20 | 16        | 50  | 10        | 7    | 3         | 6    | 55                             | 9    | +16                               | 9    |
| " 26                                            | 5                            | 37  | 3                | 43 | 11        | 13  | 10                | 29 | 17        | 59  | 10        | 1    | 3         | 7    | 56                             | 8    | +12                               | 3    |
| " 27                                            | 6                            | 01  | 6                | 13 | 10        | 28  | 12                | 36 | 16        | 51  | 7         | 1    | 6         | 6    | 57                             | 7    | +7                                | 0    |
| " 28                                            | 6                            | 25  | 4                | 43 | ...       | ... | 10                | 42 | ...       | ... | 9         | 9    | ...       | ...  | 58                             | 0    | +1                                | 2    |
| " 29                                            | 6                            | 48  | 4                | 48 | ...       | ... | 13                | 48 | 18        | 32  | 8         | 5    | 3         | 7    | 59                             | 6    | -4                                | 9    |
| " 30                                            | 7                            | 11  | 6                | 43 | 0         | 13  | 11                | 55 | 17        | 48  | 9         | 5    | 3         | 4    | 60                             | 5    | -10                               | 0    |
| " 1                                             | 7                            | 34  | 7                | 48 | 0         | 43  | 12                | 37 | 17        | 55  | 8         | 8    | 3         | 7    | 61                             | 0    | -16                               | 5    |
| " 2                                             | 8                            | 56  | 6                | 57 | 1         | 42  | 11                | 23 | 18        | 31  | 10        | 3    | 6         | 9    | 61                             | 4    | -21                               | 1    |
| " 3                                             | 8                            | 29  | 8                | 12 | 1         | 42  | 12                | 46 | 17        | 38  | 9         | 4    | 4         | 2    | 61                             | 0    | -24                               | 3    |
| " 4                                             | 8                            | 44  | 8                | 27 | 2         | 42  | 12                | 07 | 18        | 46  | 9         | 9    | 4         | 3    | 61                             | 0    | -25                               | 7    |
| " 5                                             | 9                            | 08  | 9                | 12 | 4         | 12  | 12                | 58 | 19        | 22  | 10        | 9    | 2         | 7    | 60                             | 5    | -22                               | 9    |
| " 6                                             | 9                            | 33  | 9                | 42 | 4         | 12  | 12                | 04 | 19        | 28  | 11        | 2    | 3         | 4    | 59                             | 6    | -22                               | 9    |
| " 7                                             | 9                            | 58  | 10               | 12 | 4         | 12  | 12                | 39 | 19        | 04  | 12        | 0    | 2         | 2    | 58                             | 7    | -19                               | 4    |
| " 8                                             | 10                           | 24  | 11               | 11 | 4         | 41  | 13                | 13 | 19        | 08  | 12        | 5    | 2         | 6    | 61                             | 0    | -16                               | 5    |
| " 9                                             | 10                           | 51  | 11               | 41 | 4         | 41  | 13                | 17 | 18        | 43  | 13        | 8    | 0         | 7    | 61                             | 4    | -21                               | 1    |
| " 10                                            | 11                           | 20  | 10               | 56 | 4         | 41  | 11                | 05 | 17        | 47  | 10        | 7    | 1         | 2    | 61                             | 0    | -16                               | 5    |
| " 11                                            | 11                           | 50  | 10               | 56 | 4         | 41  | 11                | 36 | 17        | 50  | 13        | 7    | 0         | 1    | 61                             | 4    | -24                               | 3    |
| " 12                                            | ...                          | ... | ...              | 5  | 26        | ... | ...               | 18 | 06        | ... | ...       | ...  | ...       | ...  | 54                             | 9    | +6                                | 3    |
| Dec. 1                                          | 0                            | 21  | 0                | 11 | 5         | 41  | 12                | 21 | 17        | 51  | 10        | 8    | 1         | 2    | 61                             | 4    | -24                               | 3    |
| " 2                                             | 0                            | 53  | 0                | 11 | 6         | 26  | 11                | 50 | 18        | 05  | 12        | 8    | 0         | 3    | 61                             | 0    | -25                               | 7    |
| " 3                                             | 1                            | 25  | 0                | 10 | 6         | 10  | 11                | 47 | 17        | 17  | 9         | 5    | 2         | 1    | 61                             | 0    | -25                               | 7    |
| " 4                                             | 1                            | 58  | 1                | 10 | 7         | 10  | 11                | 42 | 17        | 12  | 9         | 4    | 0         | 4    | 60                             | 4    | -25                               | 2    |
| " 5                                             | 2                            | 30  | 1                | 55 | 8         | 40  | 11                | 25 | 18        | 10  | 12        | 8    | 0         | 1    | 59                             | 6    | -22                               | 9    |
| " 6                                             | 3                            | 03  | 1                | 54 | 6         | 39  | 10                | 51 | 15        | 36  | 8         | 3    | 0         | 1    | 58                             | 7    | -19                               | 4    |
| " 7                                             | 4                            | 36  | 2                | 09 | 9         | 09  | 10                | 37 | 17        | 37  | 13        | 7    | 1         | 6    | 58                             | 7    | -14                               | 9    |
| " 8                                             | 5                            | 09  | 2                | 39 | 8         | 54  | 10                | 36 | 16        | 51  | 9         | 1    | 1         | 3    | 57                             | 7    | -19                               | 4    |
| " 9                                             | 5                            | 42  | 3                | 39 | 9         | 39  | 11                | 08 | 17        | 08  | 11        | 1    | 1         | 0    | 57                             | 7    | -14                               | 9    |
| " 10                                            | 6                            | 15  | 3                | 09 | 8         | 24  | 10                | 09 | 15        | 24  | 6         | 1    | 2         | 3    | 56                             | 9    | -9                                | 8    |
| " 11                                            | 6                            | 52  | 4                | 24 | 11        | 39  | 10                | 58 | 18        | 13  | 10        | 3    | 1         | 0    | 56                             | 9    | -9                                | 8    |
| " 12                                            | 7                            | 26  | 4                | 38 | ...       | ... | 12                | 46 | ...       | ... | 6         | 8    | ...       | ...  | 56                             | 1    | -4                                | 4    |
| " 13                                            | 7                            | 53  | 5                | 23 | 1         | 08  | 13                | 39 | 18        | 16  | 10        | 6    | 3         | 5    | 56                             | 1    | -4                                | 4    |
| " 14                                            | 8                            | 26  | 6                | 03 | 1         | 08  | 11                | 45 | 18        | 54  | 7         | 6    | 3         | 5    | 56                             | 1    | -4                                | 4    |
| " 15                                            | 8                            | 59  | 6                | 37 | 1         | 07  | 13                | 15 | 18        | 07  | 11        | 2    | 3         | 6    | 55                             | 4    | +1                                | 0    |
| " 16                                            | 9                            | 07  | 8                | 07 | 2         | 07  | 12                | 25 | 18        | 45  | 11        | 8    | 5         | 2    | 54                             | 9    | +6                                | 3    |
| " 17                                            | 9                            | 37  | 8                | 37 | 2         | 07  | 13                | 33 | 18        | 25  | 11        | 1    | 5         | 3    | 54                             | 9    | +6                                | 3    |
| " 18                                            | 9                            | 57  | 9                | 07 | 2         | 07  | 12                | 42 | 18        | 03  | 9         | 2    | 5         | 3    | 54                             | 9    | +6                                | 3    |

## RECORD AND REDUCTION OF THE TIDES.

13

## SERIES I.—FROM OCTOBER 10 TO DECEMBER 28, 1853.

| DATE.<br>1853. | Moon passes<br>the meridian. |     | Apparent time of |     | Lunifidal interval. |     |           |     | Height of |     |           |      | Moon's<br>parallax<br>at noon. |      | Moon's<br>declination<br>at noon. |      |
|----------------|------------------------------|-----|------------------|-----|---------------------|-----|-----------|-----|-----------|-----|-----------|------|--------------------------------|------|-----------------------------------|------|
|                | Appar. time.                 |     | H. water.        |     | L. water.           |     | H. water. |     | L. water. |     | H. water. |      | L. water.                      |      | Min.                              | Dec. |
|                | H.                           | M.  | H.               | M.  | H.                  | M.  | H.        | M.  | H.        | M.  | Ft.       | Dec. | Ft.                            | Dec. |                                   |      |
| Dec. 11        | 9                            | 06  | 9                | 51  | 3                   | 36  | 13        | 05  | 19        | 11  | 9         | 5    | 1                              | 7    | 54                                | 5    |
| " 12           | 9                            | 27  | 9                | 36  | 3                   | 36  | 12        | 30  | 18        | 50  | 7         | 8    | 1                              | 8    | 54                                | 2    |
| " 13           | 10                           | 10  | 11               | 06  | 4                   | 06  | 13        | 39  | 19        | 00  | 9         | 9    | 0                              | 3    | 54                                | 0    |
| " 14           | 10                           | 31  | 11               | 05  | 4                   | 05  | 13        | 17  | 19        | 09  | 9         | 0    | 2                              | 8    | 54                                | 0    |
| " 15           | 10                           | 54  | 10               | 20  | 4                   | 35  | 11        | 49  | 18        | 25  | 8         | 0    | 2                              | 8    | 54                                | 0    |
| " 16           | 11                           | 17  | 11               | 05  | 4                   | 35  | 12        | 11  | 18        | 04  | 12        | 5    | 2                              | 3    | 53                                | 9    |
| " 17           | 11                           | 41  | 11               | 05  | 6                   | 05  | 11        | 48  | 19        | 11  | 8         | 9    | 2                              | 4    | 53                                | 9    |
| " 18           | ...                          | ... | ...              | ... | 5                   | 05  | ...       | ... | 17        | 48  | ...       | ...  | 2                              | 4    | 53                                | 9    |
| " 19           | 0                            | 06  | 1                | 04  | 6                   | 04  | 13        | 28  | 18        | 04  | 13        | 2    | 5                              | 5    | 54                                | 0    |
| " 20           | 0                            | 30  | 0                | 04  | 5                   | 04  | 11        | 28  | 16        | 58  | 12        | 5    | 3                              | 4    | 54                                | 0    |
| " 21           | 0                            | 55  | 0                | 19  | 7                   | 19  | 11        | 49  | 18        | 49  | 12        | 8    | 1                              | 6    | 54                                | 2    |
| " 22           | 1                            | 20  | 0                | 34  | 6                   | 03  | 11        | 39  | 17        | 08  | 7         | 5    | 2                              | 7    | 54                                | 2    |
| " 23           | 1                            | 44  | ...              | ... | 5                   | 18  | ...       | ... | 15        | 58  | ...       | ...  | 0                              | 6    | 54                                | 5    |
| " 24           | 2                            | 09  | 1                | 03  | 7                   | 03  | 11        | 19  | 17        | 19  | ...       | ...  | ...                            | ...  | 54                                | 5    |
| " 25           | 2                            | 34  | ...              | ... | ...                 | ... | ...       | ... | ...       | ... | ...       | ...  | ...                            | ...  | 54                                | 8    |
| " 26           | 2                            | 58  | 2                | 03  | 7                   | 32  | ...       | ... | ...       | ... | ...       | ...  | ...                            | ...  | 54                                | 8    |
| " 27           | 3                            | 22  | 1                | 32  | 8                   | 02  | 10        | 34  | 17        | 04  | ...       | ...  | ...                            | ...  | 54                                | 3    |
| " 28           | 3                            | 46  | 2                | 17  | 8                   | 32  | 10        | 55  | 17        | 10  | 10        | 9    | 1                              | 4    | 55                                | 3    |
| " 29           | 4                            | 09  | 2                | 47  | 6                   | 02  | 11        | 01  | 14        | 16  | 10        | 4    | ...                            | ...  | 55                                | 3    |
| " 30           | 4                            | 32  | 3                | 02  | 8                   | 31  | 11        | 51  | 16        | 22  | 11        | 6    | 4                              | 5    | 55                                | 9    |
| " 31           | 4                            | 54  | 3                | 46  | 9                   | 41  | 11        | 14  | 16        | 59  | 11        | 5    | 4                              | 4    | 56                                | 5    |
| " 1            | 5                            | 17  | 4                | 31  | 9                   | 14  | 11        | 37  | 16        | 22  | 9         | 1    | 5                              | 1    | 56                                | 5    |
| " 2            | 5                            | 39  | 4                | 31  | 11                  | 01  | 11        | 14  | 17        | 14  | 11        | 6    | 4                              | 2    | 57                                | 4    |
| " 3            | 6                            | 01  | 5                | 31  | 11                  | 30  | 11        | 52  | 17        | 51  | 7         | 5    | 3                              | 1    | 57                                | 4    |
| " 4            | 6                            | 24  | 4                | 30  | 11                  | 30  | 10        | 29  | 17        | 29  | 8         | 8    | 2                              | 9    | 58                                | 3    |
| " 5            | 6                            | 47  | 7                | 00  | ...                 | ... | ...       | ... | ...       | ... | 7         | 8    | ...                            | ...  | 58                                | 3    |
| " 6            | 7                            | 10  | 6                | 30  | 0                   | 00  | 11        | 43  | 17        | 36  | 9         | 3    | 4                              | 6    | 59                                | 2    |
| " 7            | 7                            | 34  | 8                | 00  | 1                   | 15  | 12        | 50  | 18        | 28  | 8         | 0    | 2                              | 4    | 59                                | 2    |
| " 8            | 7                            | 59  | 7                | 30  | 0                   | 15  | 11        | 56  | 17        | 05  | 7         | 3    | 4                              | 1    | 60                                | 0    |
| " 9            | 8                            | 23  | 8                | 29  | 1                   | 44  | 12        | 30  | 18        | 10  | 11        | 5    | 3                              | 2    | 60                                | 0    |
| " 10           | 8                            | 50  | 8                | 14  | 2                   | 44  | 11        | 51  | 18        | 45  | 9         | 2    | 4                              | 8    | 60                                | 7    |
| " 11           | 9                            | 18  | 9                | 28  | 1                   | 59  | 12        | 38  | 17        | 36  | 11        | 2    | 1                              | 8    | 61                                | 2    |
| " 12           | 9                            | 46  | 9                | 28  | 3                   | 58  | 12        | 10  | 19        | 08  | 9         | 1    | 2                              | 9    | 61                                | 2    |
| " 13           | 10                           | 13  | 10               | 13  | 3                   | 28  | 12        | 27  | 18        | 10  | 11        | 6    | 1                              | 9    | 61                                | 2    |
| " 14           | 10                           | 48  | 10               | 58  | 4                   | 58  | 12        | 42  | 19        | 12  | 10        | 6    | 4                              | 9    | 61                                | 2    |

## SERIES II.—FROM JANUARY 28 TO APRIL 7, 1854.

|         |    |    |     |     |     |     |     |     |     |     |     |     |     |     |    |   |
|---------|----|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|---|
| Jan. 27 | 10 | 58 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 60 | 7 |
| " 28    | 11 | 30 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 60 | 4 |
| " 29    | 0  | 01 | 0   | 17  | 5   | 17  | 13  | 19  | 18  | 19  | 10  | 6   | 1   | 0   | 59 | 9 |
| " 30    | 0  | 31 | 0   | 17  | 6   | 17  | 12  | 47  | 18  | 47  | 12  | 4   | 2   | 6   | 59 | 1 |
| " 31    | 1  | 01 | 0   | 2   | 8   | 02  | 11  | 21  | 19  | 31  | 13  | 3   | ... | ... | 59 | 1 |
| " 1     | 1  | 27 | 0   | 16  | 6   | 01  | 11  | 15  | 17  | 00  | 9   | 0   | ... | ... | 59 | 1 |
| " 2     | 1  | 55 | 1   | 16  | 7   | 46  | 11  | 49  | 18  | 19  | 13  | 9   | ... | ... | 58 | 2 |
| " 3     | 2  | 20 | 0   | 40  | 7   | 16  | 10  | 51  | 17  | 21  | 9   | 7   | ... | ... | 58 | 2 |
| " 4     | 2  | 45 | 1   | 16  | 8   | 16  | 10  | 56  | 17  | 56  | 13  | 7   | 1   | 5   | 57 | 3 |
| " 5     | 3  | 08 | 2   | 46  | 8   | 46  | 12  | 01  | 18  | 01  | 11  | 1   | 1   | 3   | 57 | 3 |
| " 6     | 3  | 32 | 2   | 46  | 9   | 01  | 11  | 38  | 17  | 53  | 12  | 9   | 2   | 1   | 56 | 4 |
| " 7     | 3  | 54 | 4   | 01  | 9   | 01  | 12  | 29  | 17  | 29  | 10  | 0   | 2   | 0   | 56 | 4 |
| " 8     | 4  | 16 | 2   | 46  | 10  | 01  | 10  | 52  | 18  | 07  | 10  | 6   | 0   | 3   | 55 | 6 |
| " 9     | 4  | 38 | 4   | 01  | 8   | 46  | 11  | 45  | 16  | 30  | 8   | 5   | 3   | 4   | 55 | 6 |
| " 10    | 5  | 00 | 3   | 46  | 9   | 31  | 11  | 08  | 16  | 53  | 8   | 6   | 2   | 2   | 55 | 0 |
| " 11    | 5  | 21 | 4   | 46  | 9   | 01  | 11  | 46  | 16  | 01  | 9   | 2   | 3   | 8   | 55 | 0 |
| " 12    | 5  | 43 | 5   | 16  | 12  | 16  | 11  | 55  | 18  | 55  | 8   | 0   | 3   | 8   | 54 | 5 |
| " 13    | 6  | 06 | 6   | 16  | 12  | 16  | 12  | 33  | 18  | 33  | 10  | 5   | 5   | 0   | 54 | 5 |
| " 14    | 6  | 28 | 5   | 16  | 11  | 46  | 11  | 10  | 17  | 40  | 10  | 7   | 4   | 5   | 54 | 3 |
| " 15    | 6  | 51 | 8   | 16  | 11  | 46  | 13  | 48  | 17  | 18  | 9   | 5   | 3   | 8   | 54 | 3 |
| " 16    | 7  | 14 | 8   | 01  | 11  | 16  | 13  | 10  | 16  | 25  | 7   | 2   | 3   | 7   | 54 | 1 |
| " 17    | 7  | 38 | 7   | 46  | ... | ... | ... | ... | ... | ... | 9   | 4   | ... | ... | 54 | 1 |
| " 18    | 8  | 02 | 7   | 31  | 3   | 01  | 11  | 53  | 19  | 47  | 8   | 2   | 5   | 8   | 54 | 1 |

## SERIES II.—FROM JANUARY 28 TO APRIL 7, 1864.

| DATE    | Moon passes the meridian |     | Apparent time of    |     |     |     | Lunital interval.   |     |     |     | Height of           |     |     |     | Moon's parallax at noon. |      | Moon's declination at noon. |      |
|---------|--------------------------|-----|---------------------|-----|-----|-----|---------------------|-----|-----|-----|---------------------|-----|-----|-----|--------------------------|------|-----------------------------|------|
|         | Appar. time              |     | H. water. L. water. |     |     |     | H. water. L. water. |     |     |     | H. water. L. water. |     |     |     | Min.                     |      | Degree.                     |      |
|         | H.                       | M.  | H.                  | M.  | H.  | M.  | H.                  | M.  | H.  | M.  | H.                  | M.  | H.  | M.  | Dec.                     | Dec. | Degree.                     | Dec. |
| Feb. 8  | 8                        | 26  | 10                  | 01  | 2   | 46  | 13                  | 59  | 19  | 08  | 9                   | 5   | 4   | 7   | 54                       | 1    | +25                         | 4    |
| " 9     | 8                        | 50  | 9                   | 15  | 3   | 15  | 12                  | 49  | 19  | 13  | 6                   | 7   | 3   | 3   | 54                       | 3    | +25                         | 7    |
| " 9     | 9                        | 15  | 10                  | 15  | 3   | 15  | 13                  | 25  | 18  | 49  | 9                   | 7   | 3   | 8   | 54                       | 3    | +25                         | 7    |
| " 9     | 9                        | 41  | 9                   | 45  | 4   | 45  | 12                  | 40  | 19  | 55  | 7                   | 2   | 3   | 3   | 54                       | 6    | +24                         | 9    |
| " 10    | 10                       | 06  | 10                  | 15  | 5   | 15  | 12                  | 34  | 21  | 00  | 9                   | 2   | 3   | 7   | 54                       | 9    | +22                         | 8    |
| " 10    | 10                       | 32  | 11                  | 45  | 5   | 00  | 13                  | 13  | 19  | 34  | 6                   | 6   | 1   | 5   | 54                       | 9    | +22                         | 8    |
| " 11    | 10                       | 57  | 11                  | 45  | 5   | 00  | 13                  | 13  | 18  | 54  | 10                  | 5   | 1   | 3   | 54                       | 9    | +22                         | 8    |
| " 11    | 11                       | 22  | 11                  | 45  | 4   | 45  | 12                  | 18  | 18  | 13  | 7                   | 7   | 1   | 8   | 55                       | 4    | +19                         | 8    |
| " 12    | 11                       | 46  | 10                  | 45  | 5   | 00  | 11                  | 23  | 18  | 03  | 11                  | 5   | 2   | 8   | 55                       | 4    | +19                         | 8    |
| " 12    | 11                       | 46  | 11                  | 15  | 6   | 30  | 11                  | 29  | 19  | 08  | 8                   | 4   | 3   | 3   | 55                       | 8    | +15                         | 6    |
| " 13    | 0                        | 0   | 11                  | 15  | 5   | 45  | 11                  | 03  | 17  | 59  | 12                  | 6   | 4   | 1   | 55                       | 8    | +15                         | 6    |
| " 13    | 0                        | 23  | 10                  | 45  | 5   | 15  | 10                  | 12  | 17  | 05  | 10                  | 6   | 4   | 1   | 55                       | 8    | +15                         | 6    |
| " 14    | 0                        | 58  | ...                 | ... | 6   | 46  | ...                 | ... | 18  | 13  | ...                 | ... | 2   | 4   | 56                       | 3    | +10                         | 7    |
| " 14    | 1                        | 21  | 0                   | 46  | 7   | 16  | 11                  | 48  | 18  | 18  | 13                  | 6   | 2   | 6   | 56                       | 3    | +10                         | 7    |
| " 15    | 1                        | 44  | 0                   | 31  | 6   | 46  | 11                  | 10  | 17  | 25  | 11                  | 8   | 3   | 2   | 56                       | 8    | +5                          | 3    |
| " 15    | 2                        | 06  | 1                   | 16  | 7   | 46  | 11                  | 32  | 18  | 02  | 12                  | 9   | 4   | 1   | 57                       | 3    | —0                          | 3    |
| " 16    | 2                        | 29  | 0                   | 16  | 7   | 02  | 10                  | 19  | 17  | 40  | 13                  | 1   | 2   | 2   | 57                       | 3    | —0                          | 3    |
| " 16    | 2                        | 54  | 2                   | 01  | 8   | 16  | 11                  | 32  | 17  | 47  | 13                  | 1   | 2   | 3   | 57                       | 7    | —6                          | 0    |
| " 17    | 3                        | 14  | 3                   | 16  | 7   | 16  | 12                  | 25  | 16  | 25  | 12                  | 6   | 3   | 9   | 57                       | 7    | —6                          | 0    |
| " 17    | 3                        | 37  | ...                 | ... | 9   | 16  | ...                 | ... | 18  | 02  | 11                  | 7   | 0   | 3   | 58                       | 2    | —11                         | 7    |
| " 18    | 4                        | 00  | 3                   | 01  | 9   | 01  | 11                  | 24  | 17  | 24  | 10                  | 6   | 2   | 7   | 58                       | 2    | —11                         | 7    |
| " 18    | 4                        | 24  | 2                   | 16  | 9   | 16  | 10                  | 16  | 17  | 16  | 10                  | 2   | 3   | 0   | 58                       | 7    | —16                         | 8    |
| " 19    | 4                        | 49  | 3                   | 16  | 10  | 16  | 10                  | 52  | 18  | 22  | 11                  | 3   | 4   | 5   | 58                       | 7    | —16                         | 8    |
| " 19    | 5                        | 16  | 3                   | 16  | 10  | 16  | 10                  | 27  | 17  | 27  | 10                  | 7   | 3   | 0   | 59                       | 1    | —20                         | 9    |
| " 20    | 5                        | 42  | 3                   | 46  | 9   | 16  | 10                  | 30  | 16  | 00  | 10                  | 8   | 5   | 5   | 59                       | 1    | —20                         | 9    |
| " 20    | 6                        | 16  | 3                   | 46  | ... | ... | 10                  | 04  | ... | ... | 10                  | 7   | ... | ... | 59                       | 5    | —24                         | 1    |
| " 21    | 6                        | 39  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | 59                       | 5    | —24                         | 1    |
| " 21    | 7                        | 09  | ...                 | ... | 11  | 46  | ...                 | ... | 17  | 36  | ...                 | ... | 4   | 3   | 59                       | 8    | —25                         | 7    |
| " 22    | 7                        | 40  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | 4   | 3   | 59                       | 8    | —25                         | 7    |
| " 22    | 8                        | 10  | 7                   | 46  | 4   | 16  | 12                  | 06  | 21  | 07  | 9                   | 1   | 4   | 7   | 59                       | 9    | —25                         | 6    |
| " 23    | 8                        | 41  | 10                  | 16  | 2   | 46  | 11                  | 06  | 19  | 06  | 10                  | 7   | 4   | 1   | 59                       | 9    | —25                         | 6    |
| " 23    | 9                        | 12  | 8                   | 41  | 4   | 46  | 12                  | 05  | 20  | 36  | 8                   | 9   | 5   | 7   | 59                       | 9    | —23                         | 7    |
| " 24    | 9                        | 45  | 9                   | 17  | 1   | 17  | 12                  | 05  | 16  | 36  | 10                  | 3   | 3   | 3   | 59                       | 9    | —23                         | 7    |
| " 24    | 10                       | 15  | 10                  | 17  | 3   | 47  | 12                  | 32  | 18  | 55  | 9                   | 7   | 2   | 8   | 59                       | 6    | —20                         | 3    |
| " 25    | 10                       | 45  | 10                  | 17  | 3   | 47  | 12                  | 02  | 17  | 22  | 11                  | 2   | 2   | 8   | 59                       | 6    | —20                         | 3    |
| " 25    | 11                       | 13  | 10                  | 47  | 4   | 17  | 12                  | 02  | 18  | 02  | 10                  | 4   | 2   | 0   | 59                       | 2    | —15                         | 7    |
| " 26    | 11                       | 41  | 12                  | 47  | 4   | 47  | 13                  | 34  | 18  | 02  | 11                  | 9   | 1   | 0   | 59                       | 2    | —15                         | 7    |
| " 26    | ...                      | ... | 11                  | 47  | 6   | 02  | 12                  | 06  | 18  | 49  | 11                  | 3   | 3   | 0   | 58                       | 6    | —10                         | 3    |
| " 27    | 0                        | 07  | 11                  | 47  | 5   | 02  | 11                  | 40  | 17  | 21  | 12                  | 7   | 0   | 4   | 57                       | 9    | —4                          | 5    |
| " 27    | 0                        | 33  | 11                  | 47  | 6   | 02  | 11                  | 14  | 17  | 55  | 10                  | 3   | 0   | 9   | 57                       | 9    | —4                          | 5    |
| " 28    | 0                        | 57  | 12                  | 32  | 6   | 17  | 11                  | 35  | 17  | 44  | 13                  | 0   | 0   | 1   | 57                       | 9    | —4                          | 5    |
| " 28    | 1                        | 22  | 11                  | 47  | 7   | 02  | 10                  | 25  | 18  | 05  | 12                  | 4   | 1   | 1   | 57                       | 1    | +1                          | 4    |
| March 1 | 1                        | 45  | ...                 | ... | 7   | 02  | ...                 | ... | 17  | 40  | ...                 | ... | 0   | 5   | 57                       | 1    | +1                          | 4    |
| " 2     | 2                        | 09  | 1                   | 32  | 8   | 47  | 11                  | 47  | 19  | 02  | 12                  | 9   | 1   | 3   | 56                       | 4    | +7                          | 0    |
| " 2     | 2                        | 53  | 1                   | 18  | 7   | 48  | 11                  | 09  | 17  | 39  | 12                  | 0   | 2   | 5   | 56                       | 4    | +7                          | 0    |
| " 3     | 3                        | 15  | 1                   | 33  | 9   | 18  | 11                  | 52  | 18  | 47  | 13                  | 0   | 1   | 9   | 55                       | 7    | +12                         | 2    |
| " 3     | 3                        | 38  | 2                   | 03  | 8   | 18  | 11                  | 10  | 17  | 25  | 10                  | 6   | 2   | 5   | 55                       | 7    | +12                         | 2    |
| " 4     | 4                        | 00  | 2                   | 18  | 9   | 03  | 11                  | 03  | 17  | 48  | 10                  | 9   | 1   | 5   | 55                       | 0    | +16                         | 7    |
| " 4     | 4                        | 23  | 3                   | 03  | 7   | 48  | 11                  | 25  | 16  | 10  | 11                  | 1   | 3   | 9   | 55                       | 0    | +16                         | 7    |
| " 5     | 4                        | 46  | 2                   | 48  | 8   | 48  | 10                  | 48  | 16  | 48  | 11                  | 1   | 1   | 0   | 54                       | 6    | +20                         | 5    |
| " 5     | 5                        | 09  | 3                   | 48  | 8   | 48  | 11                  | 25  | 16  | 25  | 9                   | 2   | 3   | 1   | 54                       | 6    | +20                         | 5    |
| " 6     | 5                        | 32  | 3                   | 03  | 9   | 48  | 10                  | 17  | 17  | 02  | 10                  | 1   | 3   | 9   | 54                       | 3    | +23                         | 4    |
| " 6     | 5                        | 56  | 4                   | 18  | 10  | 03  | 11                  | 09  | 16  | 54  | 10                  | 5   | 6   | 1   | 54                       | 3    | +23                         | 4    |
| " 7     | 6                        | 22  | 5                   | 19  | 10  | 34  | 11                  | 47  | 17  | 02  | 9                   | 6   | 4   | 1   | 54                       | 2    | +25                         | 3    |
| " 7     | 6                        | 47  | 4                   | 49  | 10  | 49  | 10                  | 53  | 16  | 53  | 8                   | 8   | 5   | 8   | 54                       | 2    | +25                         | 3    |
| " 8     | 8                        | 02  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                      | ...  | +25                         | 5    |
| " 8     | 8                        | 28  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                      | ...  | +25                         | 5    |
| " 10    | 8                        | 53  | 9                   | 49  | 4   | 21  | 13                  | 21  | 20  | 18  | 9                   | 9   | 3   | 9   | 54                       | 9    | +23                         | 8    |
| " 11    | 9                        | 18  | 10                  | 50  | 4   | 35  | 13                  | 57  | 20  | 07  | 8                   | 8   | 5   | 0   | 55                       | 4    | +21                         | 0    |
| " 11    | 9                        | 42  | 10                  | 50  | 4   | 35  | 13                  | 32  | 19  | 42  | 10                  | 6   | 5   | 4   | 55                       | 4    | +21                         | 0    |
| " 11    | 10                       | 08  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                      | ...  | +7                          | 1    |
| " 14    | 11                       | 43  | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                 | ... | ... | ... | ...                      | ...  | +7                          | 1    |
| " 14    | 0                        | 06  | 12                  | 21  | ... | ... | 12                  | 15  | ... | ... | 11                  | 2   | ... | ... | ...                      | ...  | +7                          | 1    |

## SERIES II.—FROM JANUARY 28 TO APRIL 7, 1854.

| DATE.<br>1854. | Moon passes<br>the meridian. |     | Apparent time of |     |           |     | Lunital interval. |     |           |     | Height of |      |           |      | Moon's<br>parallax<br>at noon. |      | Moon's<br>declination<br>at noon. |      |
|----------------|------------------------------|-----|------------------|-----|-----------|-----|-------------------|-----|-----------|-----|-----------|------|-----------|------|--------------------------------|------|-----------------------------------|------|
|                | Appar. time.                 |     | H. water.        |     | L. water. |     | H. water.         |     | L. water. |     | H. water. |      | L. water. |      | Min.                           | Sec. | Degree.                           | Dec. |
|                | H.                           | M.  | H.               | M.  | H.        | M.  | H.                | M.  | H.        | M.  | Ft.       | Dec. | Ft.       | Dec. |                                |      |                                   |      |
| Mar. 15        | 0                            | 29  | 11               | 21  | 6         | 21  | 10                | 52  | 18        | 15  | 12        | 7    | 2         | 3    | 57                             | 0    | + 1                               | 3    |
| " 16           | 0                            | 52  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 58                             | 1    | - 4                               | 6    |
| " 17           | 1                            | 15  | 0                | 36  | 8         | 21  | 11                | 44  | 19        | 20  | 10        | 5    | 3         | 2    | 58                             | 1    | - 10                              | 5    |
| " 18           | 2                            | 02  | 1                | 36  | 8         | 21  | 11                | 58  | 18        | 43  | 12        | 0    | 0         | 7    | 58                             | 5    | - 15                              | 8    |
| " 19           | 3                            | 18  | 1                | 52  | 8         | 07  | 11                | 00  | 17        | 15  | 9         | 5    | 3         | 1    | 59                             | 0    | - 20                              | 4    |
| " 20           | 4                            | 12  | 2                | 37  | 8         | 37  | 10                | 53  | 16        | 53  | 10        | 7    | 2         | 6    | 59                             | 2    | - 23                              | 8    |
| " 21           | 4                            | 40  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | ...                            | ...  | - 26                              | 0    |
| " 22           | 7                            | 11  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 59                             | 2    | - 24                              | 6    |
| " 23           | 7                            | 42  | 7                | 23  | ...       | ... | ...               | ... | ...       | ... | 9         | 5    | ...       | ...  | 59                             | 0    | - 21                              | 0    |
| " 24           | 8                            | 12  | 8                | 23  | 1         | 53  | 12                | 41  | 18        | 42  | 8         | 5    | 5         | 3    | 58                             | 7    | - 17                              | 5    |
| " 25           | 9                            | 11  | 10               | 30  | 2         | 24  | 13                | 57  | 18        | 12  | 9         | 2    | 5         | 3    | 58                             | 3    | - 12                              | 4    |
| " 26           | 9                            | 39  | 9                | 54  | 3         | 54  | 12                | 43  | 19        | 12  | 10        | 3    | 5         | 1    | 57                             | 3    | - 6                               | 7    |
| " 27           | 10                           | 05  | 9                | 54  | 3         | 54  | 12                | 15  | 18        | 43  | 9         | 6    | 4         | 3    | 57                             | 3    | - 0                               | 8    |
| " 28           | 10                           | 31  | 9                | 24  | 4         | 24  | 11                | 19  | 18        | 45  | 11        | 7    | 3         | 8    | 56                             | 7    | + 4                               | 5    |
| " 29           | 10                           | 55  | 11               | 24  | 4         | 30  | 12                | 53  | 18        | 34  | 11        | 4    | 3         | 4    | 54                             | 1    | + 10                              | 4    |
| " 30           | 11                           | 19  | 10               | 54  | 4         | 54  | 11                | 59  | 18        | 23  | 11        | 9    | 2         | 2    | 55                             | 5    | + 15                              | 3    |
| " 31           | 11                           | 43  | 11               | 25  | 5         | 25  | 12                | 06  | 18        | 30  | 10        | 9    | 1         | 3    | 54                             | 0    | + 22                              | 3    |
| " 1            | ...                          | ... | 11               | 25  | 5         | 55  | 11                | 42  | 18        | 36  | 12        | 0    | 2         | 0    | 54                             | 3    | + 26                              | 1    |
| " 2            | 0                            | 07  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 54                             | 3    | + 26                              | 1    |
| " 3            | 0                            | 29  | 0                | 40  | 6         | 25  | 12                | 33  | 18        | 18  | 12        | 0    | 3         | 5    | 54                             | 6    | + 24                              | 8    |
| " 4            | 0                            | 52  | 0                | 40  | 6         | 25  | 12                | 11  | 17        | 50  | 14        | 5    | - 0       | 2    | 55                             | 0    | + 22                              | 3    |
| " 5            | 1                            | 14  | 1                | 55  | 7         | 55  | 13                | 03  | 19        | 03  | 12        | 5    | 3         | 3    | 55                             | 5    | + 15                              | 3    |
| " 6            | 1                            | 36  | 0                | 0   | 7         | 41  | 10                | 40  | 18        | 27  | 13        | 5    | 1         | 3    | 54                             | 1    | + 10                              | 4    |
| " 7            | 1                            | 59  | 1                | 41  | 7         | 56  | 12                | 03  | 18        | 20  | 11        | 5    | 1         | 5    | 54                             | 3    | + 26                              | 1    |
| " 8            | 2                            | 22  | 1                | 56  | 8         | 56  | 11                | 57  | 18        | 57  | 13        | 0    | 3         | 3    | 55                             | 5    | + 15                              | 3    |

## SERIES III.—FROM APRIL 20 TO AUGUST 3, 1854.

| DATE.    | H.  | M.  | H.  | M.  | H.  | M.  | H.  | M.  | H.  | M.  | H.  | M.  | H.  | M.  | Min. | Sec. | Degree. | Dec. |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|---------|------|
| April 19 | 6   | 17  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 58   | 8    | - 22    | 6    |
| " 20     | 6   | 45  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 58   | 4    | - 18    | 7    |
| " 21     | 7   | 13  | 6   | 01  | 0   | 16  | 11  | 10  | 17  | 59  | 8   | 1   | 5   | 1   | 57   | 9    | - 13    | 8    |
| " 22     | 7   | 41  | 7   | 31  | 0   | 31  | 12  | 18  | 17  | 46  | 10  | 0   | 4   | 5   | 57   | 4    | - 8     | 5    |
| " 23     | 8   | 07  | 7   | 49  | 1   | 31  | 12  | 05  | 15  | 18  | 7   | 2   | 4   | 0   | 57   | 0    | - 2     | 6    |
| " 24     | 8   | 35  | 8   | 02  | 1   | 17  | 11  | 55  | 17  | 36  | 10  | 4   | 4   | 0   | 56   | 4    | + 3     | 1    |
| " 25     | 8   | 59  | 8   | 47  | 3   | 17  | 13  | 12  | 19  | 10  | 9   | 8   | 4   | 0   | 56   | 0    | + 8     | 7    |
| " 26     | 9   | 24  | 9   | 17  | 3   | 02  | 11  | 18  | 18  | 27  | 10  | 7   | 4   | 1   | 55   | 5    | + 13    | 8    |
| " 27     | 9   | 47  | 19  | 17  | 4   | 32  | 12  | 53  | 19  | 33  | 9   | 6   | 1   | 8   | 55   | 0    | + 18    | 3    |
| " 28     | 10  | 10  | 9   | 02  | 3   | 32  | 11  | 15  | 18  | 08  | 11  | 1   | 2   | 5   | 54   | 7    | + 21    | 9    |
| " 29     | 10  | 32  | 9   | 32  | 4   | 32  | 11  | 22  | 18  | 45  | 9   | 9   | 1   | 7   | 54   | 0    | + 8     | 7    |
| " 30     | 10  | 54  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 54   | 0    | + 18    | 3    |
| " 1      | 11  | 16  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 54   | 7    | + 21    | 9    |
| " 2      | 11  | 38  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 54   | 7    | + 21    | 9    |
| " 3      | 12  | 00  | 0   | 02  | 6   | 32  | 12  | 46  | 19  | 16  | 12  | 0   | 0   | 1   | 54   | 7    | + 21    | 9    |
| " 4      | ... | ... | 1   | 02  | 6   | 47  | 13  | 24  | 10  | 09  | 11  | 5   | 1   | 0   | 55   | 5    | + 13    | 8    |
| " 5      | 0   | 22  | 0   | 32  | 5   | 02  | 12  | 32  | 17  | 02  | 12  | 2   | 2   | 2   | 55   | 0    | + 18    | 3    |
| " 6      | 0   | 45  | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 54   | 7    | + 21    | 9    |
| " 7      | 1   | 09  | 1   | 03  | 7   | 03  | 12  | 18  | 18  | 18  | 11  | 6   | 2   | 0   | 54   | 7    | + 21    | 9    |
| " 8      | 1   | 33  | 0   | 33  | 7   | 33  | 11  | 24  | 18  | 24  | 13  | 0   | 2   | 1   | 54   | 7    | + 21    | 9    |
| " 9      | 1   | 56  | 0   | 03  | 5   | 33  | 10  | 30  | 16  | 00  | 12  | 0   | 1   | 5   | 54   | 7    | + 21    | 9    |

## SERIES III.—FROM APRIL 20 TO AUGUST 3, 1854.

| Series III.—From April 20 to August 3, 1854. |                           |     |                  |     |           |     |                    |     |           |     |           |     |           |     |                          |      |                             |      |
|----------------------------------------------|---------------------------|-----|------------------|-----|-----------|-----|--------------------|-----|-----------|-----|-----------|-----|-----------|-----|--------------------------|------|-----------------------------|------|
| Date.                                        | Moon passes the meridian. |     | Apparent time of |     |           |     | Lunithal interval. |     |           |     | Height of |     |           |     | Moon's parallax at noon. |      | Moon's declination at noon. |      |
|                                              | Appar. time.              |     | H. water.        |     | L. water. |     | H. water.          |     | L. water. |     | H. water. |     | L. water. |     | Min.                     | Dec. | Degree.                     | Dec. |
|                                              | 1854.                     | H.  | M.               | H.  | M.        | H.  | M.                 | H.  | M.        | H.  | M.        | Fe. | Dec.      | Fe. |                          |      |                             |      |
| April 30                                     | 2                         | 20  | 0                | 03  | 5         | 33  | 10                 | 07  | 15        | 37  | 12        | 9   | 1         | 9   | 54                       | 4    | +24                         | 5    |
| May 1                                        | 2                         | 45  | 0                | 33  | 5         | 17  | 10                 | 13  | 14        | 57  | 11        | 3   | 1         | 7   | 54                       | 2    | +26                         | 0    |
|                                              | 3                         | 09  | 0                | 33  | 7         | 03  | 9                  | 24  | 15        | 54  | 9         | 4   | 3         | 7   | 54                       | 2    | +26                         | 3    |
|                                              | 4                         | 25  | 2                | 33  | 9         | 03  | 10                 | 59  | 17        | 29  | 12        | 4   | 1         | 8   | 54                       | 2    | +26                         | 3    |
| " 3                                          | 4                         | 50  | 3                | 48  | 9         | 03  | 11                 | 23  | 16        | 38  | 9         | 6   | 5         | 3   | 54                       | 3    | +25                         | 4    |
| " 4                                          | 5                         | 15  | 3                | 03  | 9         | 03  | 10                 | 13  | 16        | 13  | 9         | 1   | 6         | 5   | 54                       | 6    | +23                         | 4    |
|                                              | 5                         | 39  | 4                | 33  | ...       | ... | 11                 | 18  | ...       | ... | 10        | 5   | ...       | ... | 54                       | 6    | +23                         | 4    |
|                                              | 6                         | 04  | ...              | ... | ...       | ... | ...                | ... | ...       | ... | ...       | ... | ...       | ... | 55                       | 6    | +16                         | 3    |
| " 6                                          | 7                         | 14  | ...              | ... | ...       | ... | ...                | ... | ...       | ... | ...       | ... | ...       | ... | 56                       | 4    | +11                         | 4    |
| " 7                                          | 7                         | 38  | ...              | ... | ...       | ... | ...                | ... | ...       | ... | ...       | ... | ...       | ... | 57                       | 3    | +6                          | 0    |
| " 8                                          | 8                         | 25  | 8                | 34  | 1         | 04  | 12                 | 09  | 17        | 02  | 11        | 5   | 5         | 2   | 57                       | 3    | +6                          | 0    |
| " 9                                          | 9                         | 10  | 10               | 19  | 4         | 04  | 13                 | 31  | 19        | 39  | 8         | 1   | 2         | 7   | 58                       | 1    | 0                           | 0    |
| " 9                                          | 9                         | 34  | 8                | 34  | 2         | 04  | 11                 | 24  | 17        | 16  | 11        | 3   | 4         | 4   | 58                       | 1    | 0                           | 0    |
| " 10                                         | 9                         | 56  | 9                | 04  | 3         | 19  | 11                 | 31  | 18        | 09  | 9         | 4   | 1         | 8   | 58                       | 5    | -6                          | 0    |
| " 10                                         | 10                        | 19  | 10               | 49  | 5         | 34  | 12                 | 53  | 20        | 01  | 8         | 9   | 2         | 0   | 58                       | 5    | -6                          | 0    |
| " 11                                         | 10                        | 43  | 12               | 04  | 3         | 34  | 13                 | 45  | 17        | 28  | 11        | 8   | 2         | 2   | 59                       | 7    | -12                         | 0    |
| " 11                                         | 11                        | 09  | 11               | 04  | 4         | 34  | 12                 | 23  | 18        | 15  | 10        | 5   | 1         | 9   | 59                       | 7    | -12                         | 0    |
| " 11                                         | 11                        | 35  | 10               | 49  | 5         | 04  | 11                 | 40  | 18        | 21  | 13        | 7   | 1         | 3   | 60                       | 2    | -17                         | 4    |
| " 12                                         | 12                        | 02  | 12               | 04  | 5         | 49  | 12                 | 29  | 18        | 40  | 11        | 0   | 1         | 0   | 60                       | 2    | -17                         | 4    |
| " 12                                         | ...                       | ... | 11               | 34  | 4         | 34  | 11                 | 32  | 16        | 50  | 13        | 1   | 0         | 9   | 60                       | 5    | -22                         | 0    |
| " 13                                         | 0                         | 26  | 10               | 49  | ...       | ... | 10                 | 19  | ...       | ... | 12        | 4   | ...       | ... | 60                       | 5    | -22                         | 0    |
| " 13                                         | 0                         | 50  | 11               | 04  | 5         | 19  | 10                 | 04  | 16        | 49  | 13        | 6   | 1         | 3   | 60                       | 6    | -25                         | 0    |
| " 14                                         | 1                         | 30  | ...              | ... | ...       | ... | ...                | ... | ...       | ... | ...       | ... | ...       | ... | 60                       | 6    | -25                         | 0    |
| " 14                                         | 2                         | 01  | 0                | 4   | 6         | 19  | 10                 | 34  | 16        | 49  | 11        | 3   | 0         | 8   | 60                       | 4    | -26                         | 3    |
| " 15                                         | 2                         | 24  | 0                | 49  | 7         | 34  | 10                 | 48  | 17        | 33  | 13        | 9   | 1         | 7   | 60                       | 4    | -26                         | 3    |
| " 15                                         | 3                         | 05  | 1                | 49  | 8         | 19  | 11                 | 16  | 17        | 46  | 12        | 3   | 0         | 5   | 60                       | 4    | -26                         | 3    |
| " 16                                         | 3                         | 38  | 0                | 49  | 8         | 04  | 9                  | 44  | 16        | 59  | 12        | 4   | 1         | 8   | 60                       | 4    | -26                         | 3    |
| " 17                                         | 4                         | 09  | 2                | 49  | 9         | 04  | 10                 | 56  | 15        | 41  | 10        | 4   | 2         | 3   | 59                       | 4    | -23                         | 5    |
| " 17                                         | 4                         | 41  | 2                | 49  | 9         | 04  | 10                 | 40  | 16        | 55  | 12        | 8   | 1         | 8   | 59                       | 4    | -23                         | 5    |
| " 18                                         | 5                         | 10  | 2                | 49  | 8         | 19  | 10                 | 08  | 15        | 38  | 10        | 6   | 2         | 0   | 59                       | 4    | -23                         | 5    |
| " 18                                         | 5                         | 40  | 3                | 49  | 10        | 49  | 10                 | 36  | 17        | 59  | 12        | 5   | 1         | 8   | 58                       | 8    | -19                         | 8    |
| " 19                                         | 6                         | 07  | 3                | 49  | 9         | 19  | 10                 | 09  | 15        | 39  | 9         | 6   | 4         | 2   | 58                       | 1    | -15                         | 0    |
| " 19                                         | 6                         | 34  | 5                | 19  | ...       | ... | 11                 | 12  | ...       | ... | 11        | 7   | ...       | ... | 58                       | 1    | -15                         | 0    |
| " 20                                         | 7                         | 05  | 6                | 19  | 0         | 04  | 11                 | 45  | 17        | 57  | 10        | 2   | 3         | 0   | 57                       | 5    | -9                          | 7    |
| " 20                                         | 7                         | 24  | 7                | 19  | 0         | 34  | 12                 | 20  | 18        | 00  | 9         | 8   | 5         | 2   | 57                       | 5    | -9                          | 7    |
| " 21                                         | 7                         | 47  | 8                | 34  | 3         | 04  | 13                 | 10  | 20        | 05  | 8         | 7   | 3         | 8   | 56                       | 9    | -4                          | 0    |
| " 21                                         | 8                         | 10  | 7                | 34  | 2         | 16  | 11                 | 47  | 18        | 55  | 11        | 1   | 4         | 4   | 56                       | 9    | -4                          | 0    |
| " 22                                         | 8                         | 32  | 8                | 34  | 2         | 34  | 12                 | 24  | 18        | 47  | 8         | 6   | 3         | 7   | 56                       | 3    | +1                          | 6    |
| " 22                                         | 8                         | 55  | 8                | 04  | 1         | 34  | 11                 | 32  | 17        | 24  | 10        | 6   | 3         | 4   | 56                       | 3    | +1                          | 6    |
| " 23                                         | 9                         | 16  | 9                | 04  | 3         | 19  | 12                 | 09  | 18        | 47  | 9         | 3   | 2         | 5   | 55                       | 8    | +7                          | 3    |
| " 23                                         | 9                         | 38  | 8                | 04  | 3         | 04  | 10                 | 48  | 18        | 09  | 11        | 3   | 3         | 5   | 55                       | 8    | +7                          | 3    |
| " 24                                         | 9                         | 59  | 10               | 19  | 4         | 19  | 12                 | 41  | 19        | 03  | 11        | 4   | 3         | 3   | 55                       | 3    | +12                         | 4    |
| " 24                                         | 10                        | 21  | 8                | 48  | 4         | 48  | 10                 | 49  | 19        | 16  | 9         | 9   | 4         | 0   | 55                       | 3    | +12                         | 4    |
| " 25                                         | 10                        | 43  | 11               | 48  | 4         | 18  | 13                 | 27  | 18        | 19  | 12        | 9   | 2         | 0   | 54                       | 9    | +17                         | 1    |
| " 25                                         | 11                        | 05  | 10               | 18  | 5         | 03  | 11                 | 35  | 18        | 42  | 10        | 0   | 2         | 0   | 54                       | 9    | +17                         | 1    |
| " 26                                         | 11                        | 28  | 11               | 03  | 5         | 33  | 11                 | 58  | 18        | 50  | 10        | 8   | 2         | 0   | 54                       | 6    | +20                         | 9    |
| " 26                                         | 11                        | 51  | 12               | 45  | 5         | 03  | 13                 | 17  | 17        | 58  | 9         | 7   | 2         | 7   | 54                       | 6    | +20                         | 9    |
| " 27                                         | ...                       | ... | 12               | 45  | 6         | 33  | 12                 | 54  | 19        | 05  | 12        | 5   | 3         | 4   | 54                       | 3    | +23                         | 9    |
| " 27                                         | 0                         | 15  | 10               | 48  | 6         | 18  | 10                 | 33  | 18        | 47  | 9         | 7   | 2         | 4   | 54                       | 3    | +23                         | 9    |
| " 27                                         | 0                         | 39  | ...              | ... | ...       | ... | ...                | ... | ...       | ... | ...       | ... | ...       | ... | 54                       | 1    | +25                         | 7    |
| " 28                                         | 1                         | 04  | 0                | 33  | 6         | 48  | 11                 | 54  | 18        | 09  | 10        | 7   | 1         | 6   | 54                       | 1    | +25                         | 7    |
| " 28                                         | 1                         | 29  | 0                | 03  | 4         | 48  | 10                 | 59  | 15        | 44  | 8         | 7   | 2         | 3   | 54                       | 0    | +26                         | 3    |
| " 29                                         | 1                         | 54  | 0                | 03  | 7         | 03  | 10                 | 34  | 17        | 34  | 10        | 9   | 1         | 5   | 54                       | 0    | +26                         | 3    |
| " 30                                         | 2                         | 19  | 0                | 48  | 7         | 18  | 10                 | 5   | 17        | 24  | 8         | 5   | 1         | 6   | 54                       | 0    | +26                         | 3    |
| " 30                                         | 2                         | 44  | 1                | 03  | 8         | 18  | 10                 | 44  | 17        | 59  | 12        | 0   | 2         | 5   | 54                       | 0    | +26                         | 3    |
| " 31                                         | 3                         | 09  | 2                | 18  | 6         | 48  | 11                 | 34  | 16        | 04  | 8         | 5   | 2         | 5   | 54                       | 2    | +24                         | 1    |
| " 31                                         | 3                         | 34  | 3                | 18  | 9         | 18  | 12                 | 09  | 18        | 09  | 11        | 5   | 2         | 5   | 54                       | 2    | +24                         | 1    |
| " 31                                         | 3                         | 59  | 2                | 33  | 8         | 33  | 10                 | 59  | 16        | 59  | 8         | 5   | 3         | 5   | 54                       | 5    | +21                         | 4    |
| June 1                                       | 4                         | 22  | 2                | 18  | 9         | 47  | 10                 | 19  | 17        | 48  | 11        | 0   | 4         | 0   | 54                       | 5    | +21                         | 4    |
| " 1                                          | 4                         | 47  | 4                | 17  | 10        | 02  | 11                 | 55  | 17        | 40  | 8         | 0   | 3         | 6   | 54                       | 5    | +21                         | 4    |

# RECORD AND REDUCTION OF THE TIDES.

47

## SERIES III.—FROM APRIL 20 TO AUGUST 3, 1854.

| DATE.  | Moon passes the meridian. |     | Apparent time of |     |           |     | Lunital interval. |     |           |     | Height of |      |           |      | Moon's parallax at noon. |      | Moon's declination at noon. |      |
|--------|---------------------------|-----|------------------|-----|-----------|-----|-------------------|-----|-----------|-----|-----------|------|-----------|------|--------------------------|------|-----------------------------|------|
|        | Appar. time.              |     | H. water.        |     | L. water. |     | H. water.         |     | L. water. |     | H. water. |      | L. water. |      | at noon.                 |      | at noon.                    |      |
|        | H.                        | M.  | H.               | M.  | H.        | M.  | H.                | M.  | H.        | M.  | Ft.       | Dec. | Ft.       | Dec. | Min.                     | Dec. | Degree.                     | Dec. |
| June 2 | 5                         | 09  | 4                | 02  | 10        | 32  | 11                | 15  | 17        | 45  | 9         | 8    | 3         | 7    | 54                       | 9    | +17                         | 6    |
| " 3    | 5                         | 32  | 4                | 47  | 10        | 17  | 11                | 38  | 17        | 08  | 7         | 8    | 4         | 8    | 55                       | 5    | +13                         | 1    |
| " 4    | 5                         | 54  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 9         | 6    | 4         | 5    | 56                       | 3    | + 8                         | 0    |
| " 5    | 6                         | 16  | 4                | 02  | 10        | 02  | 10                | 08  | 16        | 08  | 8         | 1    | 5         | 2    | 57                       | 2    | + 2                         | 3    |
| " 6    | 6                         | 38  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 9         | 4    | ...       | ...  | 58                       | 2    | - 3                         | 6    |
| " 7    | 7                         | 00  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 9         | 7    | ...       | ...  | 59                       | 0    | - 9                         | 5    |
| " 8    | 7                         | 22  | 8                | 02  | ...       | ... | 13                | 02  | ...       | ... | 9         | 2    | 4         | 7    | 59                       | 6    | -20                         | 1    |
| " 9    | 7                         | 44  | 9                | 02  | 0         | 32  | 13                | 40  | 17        | 32  | 10        | 4    | 4         | 0    | 61                       | 1    | -23                         | 9    |
| " 10   | 8                         | 07  | 9                | 02  | 1         | 32  | 13                | 18  | 18        | 10  | 10        | 1    | 6         | 1    | 61                       | 2    | -24                         | 0    |
| " 11   | 8                         | 30  | 8                | 02  | 2         | 32  | 11                | 55  | 18        | 48  | 10        | 4    | 4         | 0    | 61                       | 1    | -25                         | 2    |
| " 12   | 8                         | 54  | 9                | 02  | 4         | 02  | 12                | 32  | 19        | 55  | 10        | 2    | 4         | 3    | 60                       | 6    | -24                         | 5    |
| " 13   | 9                         | 18  | 9                | 02  | 3         | 02  | 12                | 08  | 18        | 32  | 11        | 1    | 3         | 4    | 59                       | 2    | -16                         | 5    |
| " 14   | 9                         | 44  | 8                | 01  | 2         | 47  | 10                | 43  | 17        | 59  | 9         | 3    | 4         | 0    | 58                       | 3    | -11                         | 2    |
| " 15   | 10                        | 10  | 10               | 01  | 2         | 31  | 12                | 17  | 17        | 13  | 11        | 6    | 1         | 8    | 57                       | 4    | - 5                         | 4    |
| " 16   | 10                        | 38  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 10        | 5    | 5         | 6    | 56                       | 7    | + 0                         | 4    |
| " 17   | 11                        | 07  | 9                | 01  | 3         | 01  | 10                | 23  | 16        | 51  | 12        | 9    | 1         | 4    | 56                       | 0    | + 6                         | 0    |
| " 18   | 11                        | 38  | 10               | 01  | 5         | 01  | 10                | 54  | 18        | 23  | 11        | 7    | 2         | 1    | 55                       | 4    | +11                         | 3    |
| " 19   | 12                        | 01  | 10               | 31  | 6         | 01  | 10                | 21  | 18        | 25  | 10        | 3    | 1         | 3    | 54                       | 9    | +16                         | 0    |
| " 20   | 0                         | 43  | 13               | 01  | 6         | 31  | 12                | 18  | 18        | 21  | 13        | 2    | 2         | 0    | 54                       | 5    | +20                         | 1    |
| " 21   | 1                         | 16  | 11               | 31  | 6         | 31  | 10                | 15  | 17        | 48  | 10        | 4    | 1         | 6    | 54                       | 1    | +25                         | 4    |
| " 22   | 1                         | 49  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 10        | 3    | 2         | 4    | 54                       | 0    | +26                         | 3    |
| " 23   | 2                         | 23  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 10        | 3    | 1         | 1    | 53                       | 9    | +26                         | 0    |
| " 24   | 3                         | 24  | 1                | 30  | 7         | 30  | 10                | 38  | 16        | 8   | 12        | 1    | 1         | 6    | 53                       | 0    | +24                         | 6    |
| " 25   | 3                         | 53  | 0                | 30  | 8         | 00  | 9                 | 06  | 16        | 36  | 10        | 3    | 1         | 3    | 54                       | 9    | +14                         | 3    |
| " 26   | 4                         | 23  | 2                | 30  | 9         | 00  | 10                | 37  | 17        | 07  | 12        | 3    | 1         | 3    | 55                       | 5    | + 9                         | 4    |
| " 27   | 4                         | 49  | 1                | 30  | 8         | 00  | 9                 | 07  | 15        | 37  | 8         | 5    | 2         | 3    | 56                       | 2    | + 4                         | 0    |
| " 28   | 5                         | 15  | 4                | 0   | 9         | 45  | 11                | 11  | 16        | 56  | 11        | 7    | 2         | 5    | 57                       | 0    | - 1                         | 7    |
| " 29   | 5                         | 44  | 2                | 0   | 9         | 00  | 8                 | 44  | 15        | 41  | 8         | 9    | 3         | 7    | 57                       | 9    | - 7                         | 5    |
| " 30   | 6                         | 04  | 3                | 0   | 9         | 00  | 9                 | 20  | 15        | 20  | 11        | 4    | 2         | 8    | ...                      | ...  | ...                         | ...  |
| " 31   | 6                         | 27  | 2                | 30  | 11        | 20  | 8                 | 26  | 17        | 25  | 9         | 3    | 4         | 6    | ...                      | ...  | ...                         | ...  |
| " 1    | 6                         | 49  | 4                | 59  | 11        | 20  | 10                | 32  | 17        | 02  | 10        | 2    | 3         | 2    | ...                      | ...  | ...                         | ...  |
| " 2    | 7                         | 11  | 4                | 59  | 11        | 59  | 10                | 10  | 17        | 10  | 10        | 5    | 5         | 6    | ...                      | ...  | ...                         | ...  |
| " 3    | 7                         | 33  | 5                | 59  | ...       | ... | 10                | 48  | ...       | ... | 10        | 5    | ...       | ...  | ...                      | ...  | ...                         | ...  |
| " 4    | 7                         | 54  | 7                | 29  | 1         | 29  | 11                | 56  | 18        | 15  | 10        | 0    | 4         | 0    | ...                      | ...  | ...                         | ...  |
| " 5    | 8                         | 16  | 7                | 59  | 2         | 14  | 12                | 05  | 18        | 41  | 9         | 9    | 3         | 2    | ...                      | ...  | ...                         | ...  |
| " 6    | 8                         | 37  | 9                | 29  | 3         | 29  | 13                | 13  | 19        | 35  | 10        | 5    | 1         | 4    | ...                      | ...  | ...                         | ...  |
| " 7    | 8                         | 59  | 8                | 59  | 2         | 44  | 13                | 22  | 18        | 28  | 9         | 4    | 5         | 8    | ...                      | ...  | ...                         | ...  |
| " 8    | 9                         | 22  | 9                | 29  | 2         | 59  | 12                | 30  | 18        | 22  | 13        | 0    | 3         | 0    | ...                      | ...  | ...                         | ...  |
| " 9    | 9                         | 44  | 9                | 28  | 2         | 58  | 12                | 06  | 17        | 50  | 9         | 9    | 2         | 9    | ...                      | ...  | ...                         | ...  |
| " 10   | 10                        | 07  | 10               | 13  | 4         | 58  | 12                | 29  | 19        | 36  | 10        | 6    | 3         | 3    | ...                      | ...  | ...                         | ...  |
| " 11   | 10                        | 31  | 9                | 28  | 3         | 58  | 11                | 21  | 18        | 14  | 8         | 5    | 3         | 6    | ...                      | ...  | ...                         | ...  |
| " 12   | 10                        | 55  | 11               | 28  | 5         | 43  | 12                | 57  | 19        | 56  | 11        | 0    | 2         | 9    | ...                      | ...  | ...                         | ...  |
| " 13   | 11                        | 19  | 12               | 13  | 4         | 28  | 13                | 18  | 17        | 57  | 8         | 1    | 3         | 6    | ...                      | ...  | ...                         | ...  |
| " 14   | 11                        | 44  | 10               | 58  | 5         | 28  | 11                | 39  | 18        | 33  | 11        | 3    | 2         | 0    | ...                      | ...  | ...                         | ...  |
| " 15   | ...                       | ... | 11               | 58  | 4         | 58  | 12                | 14  | 17        | 39  | 8         | 3    | 2         | 4    | ...                      | ...  | ...                         | ...  |
| " 16   | 0                         | 10  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | ...                      | ...  | ...                         | ...  |
| " 17   | 0                         | 35  | 1                | 13  | 4         | 58  | 13                | 03  | 16        | 48  | 12        | 1    | 2         | 4    | ...                      | ...  | ...                         | ...  |
| " 18   | 0                         | 59  | 0                | 57  | 6         | 27  | 12                | 22  | 17        | 52  | 9         | 9    | 2         | 4    | ...                      | ...  | ...                         | ...  |
| " 19   | 1                         | 24  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 12        | 3    | 1         | 9    | ...                      | ...  | ...                         | ...  |
| " 20   | 1                         | 49  | 0                | 27  | 7         | 27  | 11                | 03  | 18        | 03  | 9         | 8    | 3         | 0    | ...                      | ...  | ...                         | ...  |
| " 21   | 2                         | 13  | 0                | 57  | 7         | 57  | 11                | 08  | 18        | 08  | 11        | 4    | 3         | 2    | ...                      | ...  | ...                         | ...  |
| " 22   | 2                         | 37  | 1                | 12  | 7         | 57  | 10                | 44  | 17        | 11  | 9         | 2    | 2         | 5    | ...                      | ...  | ...                         | ...  |
| " 23   | 3                         | 00  | 1                | 12  | 7         | 57  | 10                | 35  | 17        | 20  | 11        | 4    | 3         | 6    | ...                      | ...  | ...                         | ...  |
| " 24   | 3                         | 24  | 1                | 42  | 6         | 27  | 10                | 42  | 15        | 27  | 9         | 1    | 2         | 9    | ...                      | ...  | ...                         | ...  |
| " 25   | 3                         | 48  | 3                | 27  | 8         | 57  | 12                | 03  | 17        | 33  | 12        | 3    | 3         | 9    | ...                      | ...  | ...                         | ...  |
| " 26   | 4                         | 06  | 0                | 12  | 7         | 27  | 8                 | 26  | 15        | 41  | 9         | 4    | 3         | 8    | ...                      | ...  | ...                         | ...  |
| " 27   | 4                         | 30  | 4                | 42  | 9         | 57  | 12                | 34  | 17        | 49  | 11        | 6    | 2         | 6    | ...                      | ...  | ...                         | ...  |
| " 28   | 4                         | 52  | 4                | 57  | 8         | 57  | 12                | 27  | 16        | 27  | 9         | 3    | 5         | 0    | ...                      | ...  | ...                         | ...  |
| " 29   | 5                         | 12  | 3                | 26  | 10        | 41  | 10                | 34  | 17        | 40  | 11        | 7    | 2         | 2    | ...                      | ...  | ...                         | ...  |
| " 30   | 5                         | 33  | 3                | 21  | 11        | 26  | 12                | 14  | 18        | 14  | 7         | 3    | 3         | 8    | ...                      | ...  | ...                         | ...  |
| " 31   | 5                         | 55  | 4                | 11  | 10        | 26  | 10                | 38  | 16        | 53  | 9         | 1    | 4         | 8    | ...                      | ...  | ...                         | ...  |
| " 1    | 6                         | 17  | 5                | 26  | 10        | 56  | 11                | 21  | 17        | 01  | 9         | 8    | 6         | 9    | ...                      | ...  | ...                         | ...  |
| " 2    | 6                         | 39  | 6                | 41  | 11        | 11  | 12                | 24  | 16        | 54  | 10        | 2    | 4         | 4    | ...                      | ...  | ...                         | ...  |
| " 3    | 6                         | 02  | 6                | 56  | ...       | ... | 12                | 17  | ...       | ... | 9         | 8    | ...       | ...  | ...                      | ...  | ...                         | ...  |



## SERIES IV.—FROM SEPTEMBER 7 TO OCTOBER 22, 1854.

| Date.    | Moon passes the meridian. |     | Apparent time of |     |           |     | Lunital interval. |     |           |     | Height of |      |           |      | Moon's parallax at noon. |      | Moon's declination at noon. |      |
|----------|---------------------------|-----|------------------|-----|-----------|-----|-------------------|-----|-----------|-----|-----------|------|-----------|------|--------------------------|------|-----------------------------|------|
|          | Appar. time.              |     | H. water.        |     | L. water. |     | H. water.         |     | L. water. |     | H. water. |      | L. water. |      | Min.                     | Sec. | Degree.                     | Dec. |
|          | H.                        | M.  | H.               | M.  | H.        | M.  | H.                | M.  | H.        | M.  | Ft.       | Dec. | Ft.       | Dec. |                          |      |                             |      |
| Sept. 16 | 7                         | 43  | ...              | ... | 11        | 35  | ...               | ... | 16        | 18  | ...       | ...  | 5         | 0    | 54                       | 2    | +26                         | 1    |
| " 17     | 8                         | 08  | ...              | ... | ...       | ... | ...               | ... | ...       | ... | 10        | 0    | 5         | 0    | 54                       | 3    | +24                         | 4    |
| " 18     | 8                         | 58  | 8                | 06  | 0         | 06  | 11                | 32  | 15        | 58  | 10        | 4    | 5         | 0    | 54                       | 5    | +21                         | 5    |
| " 19     | 9                         | 22  | ...              | ... | 4         | 06  | ...               | ... | 19        | 32  | 9         | 0    | 5         | 0    | 54                       | 9    | +17                         | 7    |
| " 20     | 9                         | 47  | 10               | 06  | 3         | 06  | 12                | 44  | 18        | 08  | 12        | 0    | 5         | 0    | 54                       | 3    | +13                         | 1    |
| " 21     | 10                        | 09  | 8                | 36  | 4         | 36  | 10                | 49  | 19        | 14  | 10        | 0    | 5         | 0    | 55                       | 8    | +7                          | 8    |
| " 22     | 10                        | 33  | 11               | 06  | 6         | 06  | 12                | 57  | 29        | 19  | 12        | 0    | 5         | 0    | 56                       | 4    | +2                          | 2    |
| " 23     | 11                        | 17  | ...              | ... | 5         | 07  | ...               | ... | 18        | 58  | ...       | ...  | 2         | 0    | 56                       | 9    | -3                          | 6    |
| " 24     | 11                        | 39  | 11               | 07  | 4         | 07  | 12                | 12  | 17        | 34  | 13        | 0    | 2         | 0    | 57                       | 4    | -9                          | 5    |
| " 25     | 11                        | 07  | 11               | 07  | 5         | 07  | 11                | 50  | 18        | 12  | 11        | 5    | 4         | 0    | 57                       | 9    | -14                         | 9    |
| " 26     | 11                        | 07  | 11               | 07  | 3         | 07  | 11                | 28  | 15        | 50  | 14        | 0    | 0         | 0    | 58                       | 3    | -19                         | 7    |
| " 27     | 12                        | 00  | ...              | ... | 5         | 07  | ...               | ... | 17        | 28  | ...       | ...  | 2         | 0    | 58                       | 6    | -23                         | 5    |
| " 28     | 0                         | 22  | ...              | ... | 5         | 07  | ...               | ... | 17        | 28  | ...       | ...  | 2         | 0    | 58                       | 9    | -28                         | 0    |
| " 29     | 0                         | 45  | 1                | 08  | 6         | 08  | 12                | 46  | 17        | 46  | 12        | 0    | -0        | 7    | 59                       | 4    | -25                         | 8    |
| " 30     | 1                         | 07  | 0                | 08  | 6         | 38  | 11                | 23  | 17        | 53  | 13        | 0    | 0         | 0    | 59                       | 5    | -23                         | 3    |
| Oct. 1   | 1                         | 29  | 1                | 08  | 7         | 08  | 12                | 01  | 18        | 01  | 11        | 0    | 2         | 0    | 59                       | 0    | -14                         | 2    |
| " 2      | 1                         | 52  | 0                | 08  | 7         | 08  | 10                | 39  | 17        | 39  | 13        | 0    | 1         | 0    | 58                       | 0    | -8                          | 3    |
| " 3      | 2                         | 15  | 2                | 08  | 8         | 08  | 12                | 16  | 18        | 16  | 14        | 0    | 0         | 0    | 58                       | 0    | -2                          | 0    |
| " 4      | 2                         | 39  | 1                | 08  | 8         | 08  | 10                | 53  | 17        | 53  | 13        | 0    | 0         | 0    | 57                       | 9    | +4                          | 3    |
| " 5      | 3                         | 06  | 1                | 09  | 7         | 09  | 10                | 30  | 16        | 30  | 13        | 0    | 0         | 0    | 55                       | 9    | +20                         | 0    |
| " 6      | 3                         | 32  | 2                | 09  | 8         | 09  | 11                | 03  | 17        | 03  | 12        | 0    | -1        | 0    | 55                       | 3    | +23                         | 4    |
| " 7      | 3                         | 59  | 2                | 09  | 8         | 09  | 10                | 37  | 16        | 37  | 12        | 0    | 0         | 0    | 54                       | 8    | +25                         | 7    |
| " 8      | 4                         | 27  | 3                | 09  | 8         | 09  | 11                | 10  | 16        | 10  | 13        | 0    | 0         | 0    | 54                       | 5    | +26                         | 8    |
| " 9      | 4                         | 56  | 3                | 09  | 8         | 09  | 10                | 42  | 15        | 42  | 13        | 0    | 0         | 0    | 54                       | 3    | +25                         | 3    |
| " 10     | 5                         | 25  | 4                | 09  | 9         | 09  | 11                | 13  | 16        | 13  | 12        | 0    | 2         | 0    | 54                       | 0    | +24                         | 0    |
| " 11     | 5                         | 57  | 2                | 10  | 10        | 10  | 8                 | 45  | 16        | 45  | 10        | 0    | 2         | 0    | 54                       | 4    | +20                         | 0    |
| " 12     | 6                         | 28  | 4                | 10  | 9         | 10  | 10                | 13  | 15        | 13  | 11        | 5    | 3         | 0    | 54                       | 5    | +25                         | 3    |
| " 13     | 6                         | 59  | 4                | 10  | 11        | 10  | 9                 | 42  | 16        | 42  | 9         | 0    | 3         | 0    | 54                       | 7    | +22                         | 7    |
| " 14     | 7                         | 30  | 5                | 40  | 12        | 10  | 10                | 41  | 17        | 11  | 10        | 0    | 4         | 5    | 54                       | 8    | +19                         | 2    |
| " 15     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 55                       | 2    | +14                         | 8    |
| " 16     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 55                       | 7    | +9                          | 7    |
| " 17     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 56                       | 4    | +4                          | 2    |
| " 18     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 57                       | 0    | -1                          | 6    |
| " 19     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 57                       | 7    | -7                          | 0    |
| " 20     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | 58                       | 3    | -13                         | 4    |
| " 21     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | ...                      | ...  | ...                         | ...  |
| " 22     | ...                       | ... | ...              | ... | ...       | ... | ...               | ... | ...       | ... | ...       | ...  | ...       | ...  | ...                      | ...  | ...                         | ...  |



The second form, or Table No. 2, for reduction of tides, is specially arranged to obtain the establishment and the half-monthly inequality in time and height. The first part is arranged in reference to the observed high waters; the second part, in reference to the low waters. That the inequality in time and height should also be made out from the low water, is specially important for stations where either the observations are of short extent, or else where difficulties tend to render the observations less accurate. The discussion of the low waters could not be omitted in our case. The headings to the columns of Table No. 2, explain the arrangement sufficiently. The results from the upper and lower transit of the moon are kept separate. (It need hardly be remarked that, in certain months, the sun's or moon's lower transit can be observed at Van Rensselaer Harbor.)



TABLE FOR THE REDUCTION OF TIDES—No. 2.

Showing the Interval between the App. Time of the Moon's Superior Transit and the Time of High Water, and also the Heights of High Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 3 <sup>h</sup> to 4 <sup>h</sup> .                           |           |                   |     |                     |      | 4 <sup>h</sup> to 5 <sup>h</sup> . |                 |           |                   |     |                     | 5 <sup>h</sup> to 6 <sup>h</sup> . |                                 |                                                                                                 |           |                   |     |                     |      |                                 |
|--------------------------------------------------------------|-----------|-------------------|-----|---------------------|------|------------------------------------|-----------------|-----------|-------------------|-----|---------------------|------------------------------------|---------------------------------|-------------------------------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|------|---------------------------------|
| Moon's transit.                                              |           | Lunital interval. |     | Height of H. water. |      | No. of observations and series.    | Moon's transit. |           | Lunital interval. |     | Height of H. water. |                                    | No. of observations and series. | Moon's transit.                                                                                 |           | Lunital interval. |     | Height of H. water. |      | No. of observations and series. |
| App. time.                                                   | H. water. |                   |     |                     |      |                                    | App. time.      | H. water. |                   |     |                     |                                    |                                 | App. time.                                                                                      | H. water. |                   |     |                     |      |                                 |
| H.                                                           | M.        | H.                | M.  | Ft.                 | Dec. |                                    | H.              | M.        | H.                | M.  | Ft.                 | Dec.                               |                                 | H.                                                                                              | M.        | H.                | M.  | Ft.                 | Dec. |                                 |
| 3 12                                                         | 12        | 03                | 11  | 1                   |      | I.                                 | 4 00            | 11        | 16                | 9   | 9                   |                                    | I.                              | 5 42                                                                                            | 12        | 04                | 9   | 7                   |      | I.                              |
| 3 19                                                         | 9         | 57                | 10  | 1                   |      |                                    | 4 51            | 11        | 25                | 10  | 4                   |                                    |                                 | 5 23                                                                                            | 10        | 23                | 8   | 2                   |      |                                 |
| 3 34                                                         | 10        | 40                | 11  | 5                   |      |                                    | 4 22            | 11        | 39                | 9   | 1                   |                                    |                                 | 5 14                                                                                            | 10        | 29                | 10  | 1                   |      |                                 |
| 3 03                                                         | 10        | 51                | 8   | 3                   |      |                                    | 4 24            | 10        | 20                | 10  | 7                   |                                    |                                 | 5 00                                                                                            | 10        | 09                | 6   | 1                   |      |                                 |
| 3 46                                                         | 11        | 01                | 10  | 4                   |      | II.                                | 4 03            | 10        | 36                | 9   | 1                   |                                    | II.                             | 5 52                                                                                            | 12        | 46                | 6   | 8                   |      | II.                             |
| 3 32                                                         | 12        | 29                | 10  | 0                   |      |                                    | 4 32            | 11        | 14                | 11  | 5                   |                                    |                                 | 5 17                                                                                            | 11        | 14                | 11  | 6                   |      |                                 |
| 3 14                                                         | ...       | ...               | 11  | 7                   |      |                                    | 4 16            | 11        | 45                | 8   | 5                   |                                    |                                 | 5 00                                                                                            | 11        | 46                | 9   | 2                   |      |                                 |
| 3 38                                                         | 11        | 25                | 11  | 1                   |      |                                    | 4 00            | 10        | 15                | 10  | 2                   |                                    |                                 | 5 43                                                                                            | 12        | 33                | 10  | 5                   |      |                                 |
| 3 44                                                         | 10        | 53                | 10  | 7                   |      | III.                               | 4 49            | 10        | 27                | 10  | 7                   |                                    | III.                            | 5 09                                                                                            | 11        | 09                | 10  | 5                   |      | III.                            |
| 3 34                                                         | 10        | 59                | 12  | 4                   |      |                                    | 4 23            | 11        | 25                | 9   | 2                   |                                    |                                 | 5 09                                                                                            | 11        | 09                | 10  | 5                   |      |                                 |
| 3 38                                                         | 10        | 56                | 10  | 4                   |      |                                    | 4 25            | 11        | 23                | 9   | 6                   |                                    |                                 | 5 56                                                                                            | 10        | 53                | 8   | 8                   |      |                                 |
| 3 09                                                         | 12        | 09                | 11  | 5                   |      |                                    | 4 41            | 10        | 08                | 10  | 6                   |                                    |                                 | 5 36                                                                                            | 12        | 06                | 9   | 7                   |      |                                 |
| 3 59                                                         | 10        | 19                | 11  | 0                   |      | IV.                                | 4 47            | 11        | 15                | 9   | 8                   |                                    | IV.                             | 5 15                                                                                            | 11        | 18                | 10  | 5                   |      | IV.                             |
| 3 24                                                         | 9         | 06                | 10  | 3                   |      |                                    | 4 23            | 9         | 07                | 8   | 5                   |                                    |                                 | 5 40                                                                                            | 10        | 09                | 9   | 6                   |      |                                 |
| 3 24                                                         | 12        | 03                | 12  | 3                   |      |                                    | 4 08            | 12        | 34                | 11  | 6                   |                                    |                                 | 5 32                                                                                            | ...       | ...               | 9   | 6                   |      |                                 |
| 3 00                                                         | 10        | 25                | 10  | 0                   |      |                                    | 4 52            | 10        | 34                | 11  | 7                   |                                    |                                 | 5 16                                                                                            | 8         | 44                | 8   | 9                   |      |                                 |
| 3 52                                                         | 10        | 32                | 9   | 2                   |      | IV.                                | 4 13            | ...       | ...               | 10  | 6                   |                                    | IV.                             | 5 33                                                                                            | 10        | 38                | 9   | 1                   |      | IV.                             |
| 3 30                                                         | 10        | 39                | 11  | 1                   |      |                                    | 4 56            | 10        | 28                | 9   | 3                   |                                    |                                 | 5 43                                                                                            | 11        | 11                | 10  | 5                   |      |                                 |
| 3 33                                                         | ...       | ...               | 10  | 5                   |      |                                    | 4 22            | 11        | 41                | 10  | 0                   |                                    |                                 | 5 11                                                                                            | 10        | 23                | 9   | 0                   |      |                                 |
| 3 32                                                         | 10        | 37                | 12  | 0                   |      |                                    | 4 27            | 10        | 42                | 13  | 0                   |                                    |                                 | 5 25                                                                                            | 8         | 45                | 10  | 0                   |      |                                 |
| 3 10                                                         | 11        | 03                | 14  | 0                   |      |                                    | 4 00            | 9         | 13                | 14  | 0                   |                                    |                                 |                                                                                                 |           |                   |     |                     |      |                                 |
|                                                              |           |                   |     |                     |      |                                    | 4 51            | 10        | 53                | 14  | 0                   |                                    |                                 |                                                                                                 |           |                   |     |                     |      |                                 |
| MEANS.                                                       |           |                   |     |                     |      |                                    |                 |           |                   |     |                     |                                    |                                 |                                                                                                 |           |                   |     |                     |      |                                 |
| 3 30                                                         | 10        | 57                | ... | ...                 | 19   |                                    | 4 27            | 10        | 52                | ... | ...                 | 21                                 |                                 | 5 27                                                                                            | 10        | 53                | ... | ...                 | 19   |                                 |
| 3 29                                                         | ...       | ...               | 10  | 9                   | 21   |                                    | 4 27            | ...       | ...               | 10  | 5                   | 22                                 |                                 | 5 27                                                                                            | ...       | ...               | 9   | 5                   | 20   |                                 |
| The highest and lowest value of the interval balance nearly. |           |                   |     |                     |      |                                    |                 |           |                   |     |                     |                                    |                                 | The criterion rejects no value of the interval, the two high and two low values balance nearly. |           |                   |     |                     |      |                                 |





TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of High Water, and also the Heights of High Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 0 <sup>h</sup> to 1 <sup>h</sup> . |           |                   |     |                     |      |                                 |                 | 1 <sup>h</sup> to 2 <sup>h</sup> . |      |                     |       |                                 |                 |                   |    | 2 <sup>h</sup> to 3 <sup>h</sup> . |       |                                 |  |  |  |  |  |
|------------------------------------|-----------|-------------------|-----|---------------------|------|---------------------------------|-----------------|------------------------------------|------|---------------------|-------|---------------------------------|-----------------|-------------------|----|------------------------------------|-------|---------------------------------|--|--|--|--|--|
| Moon's transit.                    |           | Lunital interval. |     | Height of H. water. |      | No. of observations and series. | Moon's transit. | Lunital interval.                  |      | Height of H. water. |       | No. of observations and series. | Moon's transit. | Lunital interval. |    | Height of H. water.                |       | No. of observations and series. |  |  |  |  |  |
| App. time.                         | H. water. | H.                | M.  | Ft.                 | Dec. |                                 |                 | H.                                 | M.   | Ft.                 | Dec.  |                                 |                 | H.                | M. | Ft.                                | Dec.  |                                 |  |  |  |  |  |
| 0 35                               | 11 10     | 10                | 7   | I.                  | 1    | 1 18                            | 11 12           | 11 5                               | I.   | 1                   | 2 02  | 11 13                           | 11 5            | I.                | 1  | 2 48                               | 10 42 | 9 9                             |  |  |  |  |  |
| 0 48                               | 11 28     | 14                | 3   |                     |      | 1 46                            | 11 45           | 14 2                               |      |                     | 2 12  | 10 54                           | 9 8             |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 44                               | 11 01     | 10                | 9   |                     |      | 1 31                            | 11 14           | 13 7                               |      |                     | 2 20  | 10 54                           | 9 8             |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 21                               | 11 50     | 12                | 8   |                     |      | 1 25                            | 11 45           | 13 6                               |      |                     | 2 30  | 11 25                           | 12 8            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 06                               | 11 58     | 12                | 5   |                     |      | 1 44                            | 11 19           | ...                                |      |                     | ...   | ...                             | ...             |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 55                               | 11 39     | 7                 | 5   | II.                 | 1    | 1 27                            | 11 49           | 13 9                               | II.  | 1                   | 2 20  | 10 56                           | 13 7            | II.               | 1  | 2 06                               | 10 10 | 13 1                            |  |  |  |  |  |
| 0 31                               | 11 31     | 13                | 3   |                     |      | 1 21                            | 11 10           | 11 8                               |      |                     | 2 51  | 12 25                           | 12 6            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 33                               | 10 12     | 10                | 6   |                     |      | 1 45                            | 11 47           | 12 0                               |      |                     | 2 31  | 11 02                           | 13 0            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 07                               | 11 40     | 12                | 7   |                     |      | 1 58                            | 11 58           | 12 0                               |      |                     | 2 26  | 11 26                           | 12 1            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 57                               | 11 35     | 13                | 0   |                     |      | 1 14                            | 10 46           | 13 5                               |      |                     | 2 36  | 11 26                           | 12 1            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 06                               | 12 15     | 11                | 2   | III.                | 1    | 1 50                            | 11 57           | 13 0                               | III. | 1                   | 2 20  | 10 13                           | 11 3            | III.              | 1  | 2 01                               | 10 48 | 13 9                            |  |  |  |  |  |
| 0 52                               | 11 44     | 10                | 5   |                     |      | 1 33                            | 10 30           | 12 0                               |      |                     | 2 44  | 11 34                           | 8 5             |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 29                               | 12 11     | 14                | 5   |                     |      | 1 00                            | 10 04           | 13 6                               |      |                     | 2 52  | 10 38                           | 12 1            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 00                               | 12 32     | 12                | 2   |                     |      | 1 04                            | 10 59           | 8 7                                |      |                     | 2 13  | 10 44                           | 9 2             |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 45                               | 12 18     | 11                | 6   |                     |      | 1 54                            | 10 54           | 8 5                                |      |                     | 2 31  | 10 39                           | 13 6            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 02                               | 11 32     | 13                | 1   | IV.                 | 1    | 1 49                            | ...             | ...                                | IV.  | 1                   | 2 26  | 11 28                           | 8 6             | IV.               | 1  | 2 13                               | 10 38 | 12 1                            |  |  |  |  |  |
| 0 15                               | 10 33     | 9                 | 7   |                     |      | 1 24                            | 11 03           | 9 8                                |      |                     | 2 21  | 11 39                           | 13 6            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 43                               | 12 18     | 13                | 2   |                     |      | 1 31                            | 11 24           | 13 3                               |      |                     | 2 24  | 10 39                           | 13 0            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 35                               | 12 22     | 9                 | 9   |                     |      | 1 36                            | 11 56           | 13 5                               |      |                     | 2 15  | 10 53                           | 13 0            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 27                               | 11 28     | 13                | 6   |                     |      | 1 29                            | 10 39           | 13 0                               |      |                     | 2 45  | 10 28                           | 13 0            |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 47                               | 10 15     | 14                | 5   | IV.                 | 1    | 1 09                            | 11 03           | 14 0                               | IV.  | 1                   |       |                                 |                 | IV.               | 1  |                                    |       |                                 |  |  |  |  |  |
| 0 00                               | 12 07     | 13                | 0   |                     |      | 1 57                            | 10 16           | 10 0                               |      |                     |       |                                 |                 |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 45                               | 11 23     | 13                | 0   |                     |      |                                 |                 |                                    |      |                     |       |                                 |                 |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 22                               | 10 50     | 14                | 0   |                     |      |                                 |                 |                                    |      |                     |       |                                 |                 |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 17                               | 11 28     | 13                | 0   |                     |      |                                 |                 |                                    |      |                     |       |                                 |                 |                   |    |                                    |       |                                 |  |  |  |  |  |
| MEANS.                             |           |                   |     |                     |      |                                 |                 |                                    |      |                     |       |                                 |                 |                   |    |                                    |       |                                 |  |  |  |  |  |
| 0 29                               | 11 34     | ...               | ... | 25                  | 1 31 | 11 13                           | ...             | ...                                | 21   | 2 27                | 10 59 | ...                             | ...             | 20                |    |                                    |       |                                 |  |  |  |  |  |
| 0 29                               | ...       | ...               | 12  | 2                   | 1 31 | ...                             | ...             | 12                                 | 3    | 21                  | 2 27  | ...                             | ...             | 11                | 8  | 19                                 |       |                                 |  |  |  |  |  |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of High Water, and also the Heights of High Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 3 <sup>h</sup> to 4 <sup>h</sup> . |           |                   |    |                     |      | 4 <sup>h</sup> to 5 <sup>h</sup> . |                 |           |                   |    |                     | 5 <sup>h</sup> to 6 <sup>h</sup> . |                                 |                 |           |                   |    |                     |      |                                 |
|------------------------------------|-----------|-------------------|----|---------------------|------|------------------------------------|-----------------|-----------|-------------------|----|---------------------|------------------------------------|---------------------------------|-----------------|-----------|-------------------|----|---------------------|------|---------------------------------|
| Moon's transit.                    |           | Lunital interval. |    | Height of H. water. |      | No. of observations and series.    | Moon's transit. |           | Lunital interval. |    | Height of H. water. |                                    | No. of observations and series. | Moon's transit. |           | Lunital interval. |    | Height of H. water. |      | No. of observations and series. |
| App. time.                         | H. water. | H.                | M. | Fe.                 | Dec. |                                    | App. time.      | H. water. | H.                | M. | Fe.                 | Dec.                               |                                 | App. time.      | H. water. | H.                | M. | Fe.                 | Dec. |                                 |
| 3                                  | 36        | 9                 | 39 | 10                  | 5    | I.                                 | 4               | 25        | 10                | 51 | 10                  | 3                                  | I.                              | 5               | 16        | 10                | 15 | 8                   | 7    | I.                              |
| 3                                  | 50        | 10                | 56 | 13                  | 0    |                                    | 4               | 52        | 11                | 54 | 10                  | 9                                  |                                 | 5               | 52        | 10                | 39 | 10                  | 7    |                                 |
| 3                                  | 59        | 10                | 35 | 9                   | 1    |                                    | 4               | 49        | 10                | 00 | 7                   | 4                                  |                                 | 5               | 37        | 12                | 36 | 7                   | 1    |                                 |
| 3                                  | 32        | 10                | 37 | 13                  | 7    |                                    | 4               | 31        | 11                | 08 | 11                  | 1                                  |                                 | 5               | 52        | 10                | 58 | 10                  | 3    |                                 |
| 3                                  | 22        | 10                | 55 | 10                  | 9    |                                    | 4               | 09        | 10                | 53 | 11                  | 6                                  |                                 | 5               | 39        | 11                | 52 | 7                   | 5    |                                 |
| 3                                  | 08        | 11                | 38 | 12                  | 9    | II.                                | 4               | 38        | 11                | 08 | 8                   | 6                                  | II.                             | 5               | 21        | 11                | 55 | 8                   | 9    | II.                             |
| 3                                  | 37        | 11                | 52 | 10                  | 6    |                                    | 4               | 24        | 10                | 52 | 11                  | 3                                  |                                 | 5               | 16        | 10                | 30 | 10                  | 8    |                                 |
| 3                                  | 15        | 11                | 03 | 10                  | 3    |                                    | 4               | 00        | 10                | 48 | 11                  | 1                                  |                                 | 5               | 32        | 11                | 47 | 9                   | 6    |                                 |
| 3                                  | 18        | 11                | 04 | 12                  | 3    |                                    | 4               | 46        | 10                | 17 | 10                  | 1                                  |                                 | 5               | 11        | 10                | 46 | 9                   | 3    |                                 |
| 3                                  | 09        | 9                 | 24 | 9                   | 4    |                                    | 4               | 12        | 12                | 10 | 12                  | 4                                  |                                 | 5               | 10        | 10                | 39 | 12                  | 5    |                                 |
| 3                                  | 59        | 10                | 34 | 10                  | 3    | III.                               | 4               | 50        | 10                | 13 | 09                  | 1                                  | III.                            | 5               | 09        | 11                | 39 | 7                   | 8    | III.                            |
| 3                                  | 05        | 9                 | 44 | 12                  | 4    |                                    | 4               | 09        | 10                | 40 | 12                  | 8                                  |                                 | 5               | 54        | 10                | 08 | 8                   | 1    |                                 |
| 3                                  | 34        | 10                | 59 | 8                   | 5    |                                    | 4               | 22        | 11                | 55 | 8                   | 0                                  |                                 | 5               | 40        | 9                 | 29 | 11                  | 4    |                                 |
| 3                                  | 53        | 10                | 37 | 12                  | 3    |                                    | 4               | 49        | 11                | 11 | 7                   | 3                                  |                                 | 5               | 12        | 12                | 14 | 7                   | 3    |                                 |
| 3                                  | 00        | 10                | 42 | 9                   | 1    |                                    | 4               | 30        | 12                | 37 | 9                   | 3                                  |                                 | 5               | 55        | 11                | 21 | 9                   | 8    |                                 |
| 3                                  | 46        | 8                 | 26 | 9                   | 4    | IV.                                | 4               | 34        | 10                | 05 | 9                   | 0                                  | IV.                             | 5               | 19        | 11                | 20 | 10                  | 5    | IV.                             |
| 3                                  | 24        | 10                | 29 | 12                  | 6    |                                    | 4               | 46        | 10                | 18 | 10                  | 0                                  |                                 | 5               | 35        | 8                 | 29 | 7                   | 0    |                                 |
| 3                                  | 09        | 12                | 45 | 11                  | 3    |                                    | 4               | 56        | 11                | 13 | 12                  | 0                                  |                                 | 5               | 57        | 10                | 13 | 11                  | 5    |                                 |
| 3                                  | 51        | 11                | 03 | 9                   | 2    |                                    | 4               | 25        | 10                | 48 | 14                  | 5                                  |                                 |                 |           |                   |    |                     |      |                                 |
| 3                                  | 10        | 11                | 23 | 11                  | 0    |                                    |                 |           |                   |    |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 3                                  | 57        | 10                | 07 | 14                  | 0    |                                    |                 |           |                   |    |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 3                                  | 06        | 11                | 03 | 13                  | 0    |                                    |                 |           |                   |    |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 3                                  | 59        | 11                | 10 | 13                  | 0    |                                    |                 |           |                   |    |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 3                                  | 35        | 9                 | 38 | 10                  | 0    |                                    |                 |           |                   |    |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |

MEANS.

|   |    |     |     |     |     |    |   |    |     |     |     |     |    |   |    |     |     |     |     |    |
|---|----|-----|-----|-----|-----|----|---|----|-----|-----|-----|-----|----|---|----|-----|-----|-----|-----|----|
| 3 | 31 | 10  | 40  | ... | ... | 26 | 4 | 33 | 11  | 01  | ... | ... | 20 | 5 | 30 | 10  | 56  | ... | ... | 18 |
| 3 | 31 | ... | ... | 11  | 1   | 26 | 4 | 33 | ... | ... | 10  | 5   | 20 | 5 | 30 | ... | ... | 9   | 4   | 18 |

The two greatest deviations from the mean, viz., 8° 26' and 12° 45', nearly balance in the mean, hence no value was rejected.

The criterion rejects no value of the interval; the low value 8° 29' is so near the limit of rejection and not balanced in the mean that I prefer to reject it.

|   |    |    |    |     |     |    |
|---|----|----|----|-----|-----|----|
| 5 | 30 | 11 | 04 | ... | ... | 17 |
|---|----|----|----|-----|-----|----|

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of High Water, and also the Heights of High Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 6 <sup>h</sup> to 7 <sup>h</sup> .                                                                                                                                                                                                                                 |           |                   |     |                     |     |                                 | 7 <sup>h</sup> to 8 <sup>h</sup> .               |           |                   |     |                     |      |                                 | 8 <sup>h</sup> to 9 <sup>h</sup> . |           |                   |     |                     |     |                                 |  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|-----|---------------------------------|--------------------------------------------------|-----------|-------------------|-----|---------------------|------|---------------------------------|------------------------------------|-----------|-------------------|-----|---------------------|-----|---------------------------------|--|
| Moon's transit.                                                                                                                                                                                                                                                    |           | Lunital interval. |     | Height of H. water. |     | No. of observations and series. | Moon's transit.                                  |           | Lunital interval. |     | Height of H. water. |      | No. of observations and series. | Moon's transit.                    |           | Lunital interval. |     | Height of H. water. |     | No. of observations and series. |  |
| App. time.                                                                                                                                                                                                                                                         | H. water. | H.                | M.  | H.                  | M.  |                                 | App. time.                                       | H. water. | H.                | M.  | H.                  | M.   |                                 | App. time.                         | H. water. | H.                | M.  | H.                  | M.  |                                 |  |
| 6 57                                                                                                                                                                                                                                                               | 11 16     | 9                 | 2   |                     |     | I.                              | 7 54                                             | 11 49     | 9                 | 5   |                     |      | I.                              | 8 47                               | 12 42     | 10                | 0   |                     |     | I.                              |  |
| 6 07                                                                                                                                                                                                                                                               | 10 54     | 7                 | 1   |                     |     |                                 | 7 46                                             | 12 30     | 8                 | 1   |                     |      |                                 | 8 35                               | ...       | ...               | 9   | 3                   |     |                                 |  |
| 6 57                                                                                                                                                                                                                                                               | 12 49     | 7                 | 0   |                     |     |                                 | 7 38                                             | 11 53     | 11                | 0   |                     |      |                                 | 8 25                               | 13 21     | 10                | 7   |                     |     |                                 |  |
| 6 48                                                                                                                                                                                                                                                               | 11 58     | 10                | 4   |                     |     |                                 | 7 11                                             | 12 37     | 8                 | 8   |                     |      |                                 | 8 44                               | 12 58     | 10                | 9   |                     |     |                                 |  |
| 6 25                                                                                                                                                                                                                                                               | 13 48     | 8                 | 5   |                     |     |                                 | 7 56                                             | 12 46     | 9                 | 4   |                     |      |                                 | 8 25                               | 12 42     | 9                 | 2   |                     |     |                                 |  |
| 6 14                                                                                                                                                                                                                                                               | 13 39     | 10                | 6   |                     |     | 7 42                            | 12 25                                            | 11        | 8                 |     |                     | 8 50 | 12 38                           | 11                                 | 2         |                   |     |                     |     |                                 |  |
| 6 24                                                                                                                                                                                                                                                               | 12 36     | 7                 | 8   |                     |     |                                 | 7 10                                             | 12 50     | 8                 | 0   |                     |      |                                 |                                    |           |                   |     |                     |     |                                 |  |
|                                                                                                                                                                                                                                                                    |           |                   |     |                     |     |                                 | 7 59                                             | 12 30     | 11                | 5   |                     |      |                                 | 8 26                               | 12 49     | 6                 | 7   |                     |     |                                 |  |
| 6 06                                                                                                                                                                                                                                                               | 11 10     | 10                | 7   |                     |     | II.                             | 7 38                                             | 11 53     | 8                 | 2   |                     |      | II.                             | 8 10                               | 14 06     | 10                | 7   |                     |     | II.                             |  |
| 6 51                                                                                                                                                                                                                                                               | 13 10     | 7                 | 2   |                     |     |                                 | 7 11                                             | 12 12     | 9                 | 5   |                     |      |                                 | 8 53                               | 13 57     | 8                 | 8   |                     |     |                                 |  |
| 6 01                                                                                                                                                                                                                                                               | 11 41     | 6                 | 9   |                     |     |                                 | 7 41                                             | 14 17     | 7                 | 5   |                     |      |                                 | 8 12                               | 11 42     | 10                | 2   |                     |     |                                 |  |
| 6 52                                                                                                                                                                                                                                                               | 14 06     | 6                 | 7   |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 |                                    |           |                   |     |                     |     |                                 |  |
| 6 07                                                                                                                                                                                                                                                               | 11 12     | 11                | 7   |                     |     | III.                            | 7 13                                             | 12 18     | 10                | 0   |                     |      | III.                            | 8 07                               | 11 55     | 10                | 4   |                     |     | III.                            |  |
| 6 59                                                                                                                                                                                                                                                               | 12 20     | 9                 | 8   |                     |     |                                 | 7 47                                             | 11 47     | 11                | 1   |                     |      |                                 | 8 59                               | 11 18     | 10                | 7   |                     |     |                                 |  |
| 6 38                                                                                                                                                                                                                                                               | 12 54     | 8                 | 6   |                     |     |                                 | 7 22                                             | 13 40     | 9                 | 2   |                     |      |                                 | 8 02                               | 13 32     | 7                 | 9   |                     |     |                                 |  |
| 6 27                                                                                                                                                                                                                                                               | 10 32     | 10                | 2   |                     |     |                                 | 7 11                                             | 10 48     | 10                | 5   |                     |      |                                 | 8 48                               | 13 31     | 8                 | 1   |                     |     |                                 |  |
| 6 39                                                                                                                                                                                                                                                               | 12 17     | 9                 | 8   |                     |     |                                 | 7 54                                             | 12 05     | 9                 | 9   |                     |      |                                 | 8 32                               | 11 32     | 10                | 6   |                     |     |                                 |  |
| 6 07                                                                                                                                                                                                                                                               | 11 47     | 9                 | 5   |                     |     |                                 | 7 26                                             | 12 30     | 10                | 6   |                     |      | 8 54                            | 12 08                              | 11        | 1                 |     |                     |     |                                 |  |
| 6 59                                                                                                                                                                                                                                                               | 13 25     | 9                 | 4   |                     |     |                                 | 7 16                                             | 13 38     | 7                 | 6   |                     |      |                                 | 8 37                               | 12 22     | 9                 | 4   |                     |     |                                 |  |
|                                                                                                                                                                                                                                                                    |           |                   |     |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 | 8 18                               | 12 38     | 11                | 2   |                     |     |                                 |  |
| 6 59                                                                                                                                                                                                                                                               | 10 41     | 10                | 0   |                     |     | IV.                             | ...                                              | ...       | ...               | ... | ...                 | IV.  | 8 01                            | 13 53                              | 8         | 7                 |     |                     |     |                                 |  |
| 6 58                                                                                                                                                                                                                                                               | ...       | ...               | ... | 10                  | 0   |                                 |                                                  |           |                   |     |                     |      |                                 |                                    |           |                   |     |                     |     |                                 |  |
|                                                                                                                                                                                                                                                                    |           |                   |     |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 | 8 08                               | 11 58     | 9                 | 0   |                     |     | IV.                             |  |
|                                                                                                                                                                                                                                                                    |           |                   |     |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 | 8 58                               | ...       | ...               | 9   | 0                   |     |                                 |  |
|                                                                                                                                                                                                                                                                    |           |                   |     |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 | 8 34                               | 13 41     | 10                | 0   |                     |     |                                 |  |
| MEANS.                                                                                                                                                                                                                                                             |           |                   |     |                     |     |                                 |                                                  |           |                   |     |                     |      |                                 |                                    |           |                   |     |                     |     |                                 |  |
| 6 33                                                                                                                                                                                                                                                               | 12 13     | ...               | ... | ...                 | ... | 19                              | 7 33                                             | 12 28     | ...               | ... | ...                 | 18   |                                 | 8 29                               | 12 44     | ...               | ... | ...                 | ... | 21                              |  |
| 6 34                                                                                                                                                                                                                                                               | ...       | ...               | ... | 9                   | 1   | 20                              | 7 33                                             | ...       | ...               | ... | 9                   | 6    | 18                              | 8 30                               | ...       | ...               | 9   | 7                   | ... | 23                              |  |
| There are two high and two low values, viz., 14 <sup>h</sup> 06 <sup>m</sup> , 13 <sup>h</sup> 48 <sup>m</sup> , and 10 <sup>h</sup> 32 <sup>m</sup> , 10 <sup>h</sup> 41 <sup>m</sup> , nearly balancing each other; there was, therefore, no rejection required. |           |                   |     |                     |     |                                 | The high and low values in the interval balance. |           |                   |     |                     |      |                                 |                                    |           |                   |     |                     |     |                                 |  |



TABLE FOR THE REDUCTION OF TIDES—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of High Water, and also the Heights of High Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 9 <sup>h</sup> to 10 <sup>h</sup> . |           |                   |    |                     |      |                                 | 10 <sup>h</sup> to 11 <sup>h</sup> . |           |                   |    |                     |      |                                 | 11 <sup>h</sup> to 12 <sup>h</sup> . |           |                   |    |                     |      |                                 |
|-------------------------------------|-----------|-------------------|----|---------------------|------|---------------------------------|--------------------------------------|-----------|-------------------|----|---------------------|------|---------------------------------|--------------------------------------|-----------|-------------------|----|---------------------|------|---------------------------------|
| Moon's transit.                     |           | Lunital interval. |    | Height of H. water. |      | No. of observations and series. | Moon's transit.                      |           | Lunital interval. |    | Height of H. water. |      | No. of observations and series. | Moon's transit.                      |           | Lunital interval. |    | Height of H. water. |      | No. of observations and series. |
| App. time.                          | H. water. | H.                | M. | Fe.                 | Dec. |                                 | App. time.                           | H. water. | H.                | M. | Fe.                 | Dec. |                                 | App. time.                           | H. water. | H.                | M. | Fe.                 | Dec. |                                 |
| 9 37                                | 12 37     | 10                | 9  |                     |      | I.                              | 10 24                                | 12 20     | 11                | 3  |                     |      | I.                              | 11 01                                | 12 30     | 12                | 0  |                     |      | I.                              |
| 9 23                                | 12 23     | 10                | 7  |                     |      |                                 | 10 11                                | 13 50     | 11                | 6  |                     |      |                                 | 11 52                                | 11 54     | 12                | 3  |                     |      |                                 |
| 9 09                                | 12 22     | 11                | 8  |                     |      |                                 | 10 34                                | 12 41     | 11                | 0  |                     |      |                                 | 11 15                                | 11 30     | 9                 | 8  |                     |      |                                 |
| 9 52                                | 11 54     | 11                | 5  |                     |      |                                 | 10 24                                | 13 17     | 13                | 8  |                     |      |                                 | 11 59                                | 12 01     | 13                | 0  |                     |      |                                 |
| 9 33                                | 12 30     | 12                | 0  |                     |      |                                 | 10 31                                | 11 49     | 8                 | 6  |                     |      |                                 | 11 20                                | 11 36     | 13                | 7  |                     |      |                                 |
| 9 06                                | 12 30     | 7                 | 8  |                     |      |                                 | 10 06                                | 13 30     | 6                 | 6  |                     |      |                                 | 11 17                                | 11 48     | 8                 | 9  |                     |      |                                 |
| 9 49                                | 13 17     | 9                 | 6  |                     |      | II.                             | 10 57                                | 12 48     | 7                 | 7  |                     |      | II.                             | 11 30                                | 12 47     | 12                | 4  |                     |      | II.                             |
| 9 40                                | 12 27     | 11                | 6  |                     |      |                                 | 10 15                                | 12 02     | 11                | 2  |                     |      |                                 | 11 46                                | 11 29     | 8                 | 4  |                     |      |                                 |
| 9 15                                | 12 30     | 7                 | 2  |                     |      |                                 | 10 05                                | 11 19     | 11                | 7  |                     |      |                                 | 11 13                                | 13 34     | 11                | 9  |                     |      |                                 |
| 9 12                                | 12 05     | 10                | 3  |                     |      |                                 | 10 55                                | 11 59     | 11                | 9  |                     |      |                                 | 11 43                                | 11 42     | 12                | 0  |                     |      |                                 |
| 9 11                                | 12 43     | 10                | 3  |                     |      |                                 | 10 32                                | 11 30     | 12                | 2  |                     |      |                                 | 11 16                                | 12 46     | 12                | 0  |                     |      |                                 |
| 9 47                                | 11 15     | 11                | 1  |                     |      |                                 | 10 19                                | 13 45     | 11                | 8  |                     |      |                                 | 11 09                                | 11 40     | 13                | 7  |                     |      |                                 |
| 9 33                                | 11 31     | 9                 | 4  |                     |      | III.                            | 10 43                                | 11 35     | 10                | 0  |                     |      | III.                            | 11 28                                | 13 17     | 9                 | 7  |                     |      | III.                            |
| 9 16                                | 10 48     | 11                | 3  |                     |      |                                 | 10 38                                | 10 23     | 12                | 9  |                     |      |                                 | 11 38                                | 13 53     | 11                | 4  |                     |      |                                 |
| 9 59                                | 10 49     | 9                 | 6  |                     |      |                                 | 10 07                                | 11 21     | 8                 | 5  |                     |      |                                 | 11 44                                | 12 14     | 8                 | 3  |                     |      |                                 |
| 9 44                                | 12 17     | 11                | 6  |                     |      |                                 | 10 55                                | 13 18     | 8                 | 1  |                     |      |                                 | 11 20                                | 12 20     | 12                | 5  |                     |      |                                 |
| 9 22                                | 12 06     | 9                 | 9  |                     |      |                                 | 10 45                                | 12 26     | 14                | 0  |                     |      |                                 | 11 17                                | 11 50     | 11                | 5  |                     |      |                                 |
| 9 47                                | 10 49     | 10                | 0  |                     |      |                                 | 10 02                                | 11 13     | 12                | 0  |                     |      |                                 | 11 36                                | 12 06     | 14                | 0  |                     |      |                                 |
| 9 19                                | 11 56     | 11                | 0  |                     |      | IV.                             | 10 46                                | 12 29     | 12                | 0  |                     |      | IV.                             | 11 30                                | 12 15     | 12                | 0  |                     |      |                                 |

MEANS.

|      |       |     |      |    |  |
|------|-------|-----|------|----|--|
| 9 30 | 12 03 | ... | ...  | 19 |  |
| 9 30 | ...   | ... | 10 4 | 19 |  |

There being three low and but one high value in the interval, it seemed preferable to adopt a mean resulting after the rejection of 10<sup>h</sup> 48<sup>m</sup>, viz:—

|      |       |     |     |    |  |
|------|-------|-----|-----|----|--|
| 9 30 | 12 07 | ... | ... | 18 |  |
|------|-------|-----|-----|----|--|

|       |       |     |      |    |  |
|-------|-------|-----|------|----|--|
| 10 29 | 12 18 | ... | ...  | 19 |  |
| 10 29 | ...   | ... | 10 9 | 19 |  |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Superior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 0 <sup>h</sup> to 1 <sup>h</sup> .                                                           |           |                   |       |                     | 1 <sup>h</sup> to 2 <sup>h</sup> . |                 |           |                   |       | 2 <sup>h</sup> to 3 <sup>h</sup> . |                                 |                 |           |                   |       |                     |                                 |
|----------------------------------------------------------------------------------------------|-----------|-------------------|-------|---------------------|------------------------------------|-----------------|-----------|-------------------|-------|------------------------------------|---------------------------------|-----------------|-----------|-------------------|-------|---------------------|---------------------------------|
| Moon's transit.                                                                              |           | Lunital interval. |       | Height of L. water. | No. of observations and series.    | Moon's transit. |           | Lunital interval. |       | Height of L. water.                | No. of observations and series. | Moon's transit. |           | Lunital interval. |       | Height of L. water. | No. of observations and series. |
| App. time.                                                                                   | L. water. |                   |       |                     |                                    | App. time.      | L. water. |                   |       |                                    |                                 | App. time.      | L. water. |                   |       |                     |                                 |
| H. M.                                                                                        | H. M.     | H. M.             | H. M. | Ft. Dec.            |                                    | H. M.           | H. M.     | H. M.             | H. M. | Ft. Dec.                           |                                 | H. M.           | H. M.     | H. M.             | H. M. | Ft. Dec.            |                                 |
| 0 13 17 02                                                                                   | 1 5       |                   |       |                     | I.                                 | 1 40 17 35      | 1 0       |                   |       |                                    | I.                              | 2 25 18 35      | 2 7       |                   |       |                     | I.                              |
| 0 57 17 31                                                                                   | 2 0       |                   |       |                     |                                    | 0 16 18 00      | 0 0       |                   |       |                                    |                                 | 2 16 17 45      | 0 3       |                   |       |                     |                                 |
| 0 19 18 42                                                                                   | 0 0       |                   |       |                     |                                    | 1 29 17 58      | 1 1       |                   |       |                                    |                                 | 2 44 17 30      | 2 3       |                   |       |                     |                                 |
| 0 21 18 54                                                                                   | 3 1       |                   |       |                     |                                    | 1 33 18 20      | 2 2       |                   |       |                                    |                                 | 2 55 17 00      | ...       |                   |       |                     |                                 |
| 0 53 17 17                                                                                   | ...       |                   |       |                     |                                    | 1 58 17 13      | 0 4       |                   |       |                                    |                                 | 2 55 17 00      | ...       |                   |       |                     |                                 |
| 0 30 18 49                                                                                   | 1 0       |                   |       |                     | II.                                | 1 30 17 55      | 0 6       |                   |       |                                    | II.                             | 2 45 18 01      | 1 3       |                   |       |                     | II.                             |
| 0 01 18 16                                                                                   | 1 3       |                   |       |                     |                                    | 1 05 17 30      | 0 5       |                   |       |                                    |                                 | 2 29 17 47      | 2 3       |                   |       |                     |                                 |
| 0 10 18 05                                                                                   | 4 1       |                   |       |                     |                                    | 1 55 17 21      | 0 4       |                   |       |                                    |                                 | 2 09 17 30      | 2 5       |                   |       |                     |                                 |
| 0 58 18 15                                                                                   | 2 6       |                   |       |                     |                                    | 1 14 18 02      | 4 1       |                   |       |                                    |                                 | 2 53 17 25      | 2 5       |                   |       |                     |                                 |
| 0 31 17 44                                                                                   | 0 1       |                   |       |                     |                                    | 1 22 17 54      | 0 5       |                   |       |                                    |                                 | 2 02 18 19      | 1 2       |                   |       |                     |                                 |
| 0 29 19 37                                                                                   | 2 7       |                   |       |                     | III.                               | 1 55 17 21      | 0 0       |                   |       |                                    | III.                            | 2 52 17 15      | 3 1       |                   |       |                     | III.                            |
| 0 07 18 18                                                                                   | 3 5       |                   |       |                     |                                    | 1 26 17 20      | 1 5       |                   |       |                                    |                                 | 2 45 18 18      | 3 0       |                   |       |                     |                                 |
| 0 52 19 03                                                                                   | 3 3       |                   |       |                     |                                    | 1 05 18 24      | 2 1       |                   |       |                                    |                                 | 2 33 17 56      | 0 8       |                   |       |                     |                                 |
| 0 22 16 41                                                                                   | 3 0       |                   |       |                     |                                    | 1 26 17 37      | 1 9       |                   |       |                                    |                                 | 2 19 17 50      | 2 6       |                   |       |                     |                                 |
| 0 30 19 49                                                                                   | 1 3       |                   |       |                     |                                    | 1 36 18 08      | 0 8       |                   |       |                                    |                                 | 2 21 17 59      | 1 1       |                   |       |                     |                                 |
| 0 39 18 09                                                                                   | 1 6       |                   |       |                     | IV.                                | 1 22 17 34      | 1 6       |                   |       |                                    | IV.                             | 2 17 17 20      | 8 0       |                   |       |                     | IV.                             |
| 0 10 18 21                                                                                   | 2 0       |                   |       |                     |                                    | 1 16 17 15      | 0 1       |                   |       |                                    |                                 | 2 02 17 08      | 1 2       |                   |       |                     |                                 |
| 0 10 16 48                                                                                   | 2 0       |                   |       |                     |                                    | 1 40 18 08      | 3 2       |                   |       |                                    |                                 | 2 48 17 24      | 1 7       |                   |       |                     |                                 |
| 0 59 15 58                                                                                   | 1 9       |                   |       |                     |                                    | 1 00 17 10      | 1 2       |                   |       |                                    |                                 | 2 04 17 31      | 0 5       |                   |       |                     |                                 |
| 0 22 17 46                                                                                   | 0 7       |                   |       |                     |                                    | 1 12 18 56      | 0 0       |                   |       |                                    |                                 | 2 47 18 16      | 1 0       |                   |       |                     |                                 |
| 0 46 16 56                                                                                   | 0 0       |                   |       |                     | IV.                                | 1 07 18 01      | 2 0       |                   |       |                                    | IV.                             | 2 55 17 30      | 0 0       |                   |       |                     | IV.                             |
|                                                                                              |           |                   |       |                     |                                    | 1 51 18 16      | 0 4       |                   |       |                                    |                                 | 2 31 17 52      | 0 0       |                   |       |                     |                                 |
|                                                                                              |           |                   |       |                     |                                    | 1 53 17 40      | 0 1       |                   |       |                                    |                                 |                 |           |                   |       |                     |                                 |
| MEANS.                                                                                       |           |                   |       |                     |                                    |                 |           |                   |       |                                    |                                 |                 |           |                   |       |                     |                                 |
| 0 30 17 49                                                                                   | ...       | ...               | ...   | 21                  |                                    | 1 29 17 34      | ...       | ...               | ...   | 21                                 |                                 | 2 31 17 43      | ...       | ...               | ...   | 21                  |                                 |
| 0 30 ...                                                                                     | ...       | ...               | 1     | 24                  |                                    | 1 29 ...        | ...       | ...               | 1     | 23                                 |                                 | 2 30 ...        | ...       | ...               | 1     | 7                   | 20                              |
| The highest and low-4 value of the intervals having in the mean, hence no value is rejected. |           |                   |       |                     |                                    |                 |           |                   |       |                                    |                                 |                 |           |                   |       |                     |                                 |
| The low value 15 <sup>h</sup> 37 <sup>m</sup> is rejected, hence new mean—                   |           |                   |       |                     |                                    |                 |           |                   |       |                                    |                                 |                 |           |                   |       |                     |                                 |
| 1 18 17 39 ... 22                                                                            |           |                   |       |                     |                                    |                 |           |                   |       |                                    |                                 |                 |           |                   |       |                     |                                 |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Superior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 3 <sup>h</sup> to 4 <sup>h</sup> .                                          |           |                   |    |                     |    | 4 <sup>h</sup> to 5 <sup>h</sup> .                                                                                                                               |                 |           |                   |    |                     | 5 <sup>h</sup> to 6 <sup>h</sup> .                                         |                                 |                 |           |                   |    |                     |    |                                 |
|-----------------------------------------------------------------------------|-----------|-------------------|----|---------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------|-------------------|----|---------------------|----------------------------------------------------------------------------|---------------------------------|-----------------|-----------|-------------------|----|---------------------|----|---------------------------------|
| Moon's transit.                                                             |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series.                                                                                                                                  | Moon's transit. |           | Lunital interval. |    | Height of L. water. |                                                                            | No. of observations and series. | Moon's transit. |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series. |
| App. time.                                                                  | L. water. | H.                | M. | H.                  | M. |                                                                                                                                                                  | App. time.      | L. water. | H.                | M. | H.                  | M.                                                                         |                                 | App. time.      | L. water. | H.                | M. | H.                  | M. |                                 |
| 3 12 17 18                                                                  | 4         | 4                 |    |                     |    | I.                                                                                                                                                               | 4 00 16 46      | 4         | 5                 |    |                     |                                                                            | I.                              | 5 42 18 34      | 5         | 4                 |    |                     |    | I.                              |
| 3 19 17 12                                                                  | 0         | 7                 |    |                     |    |                                                                                                                                                                  | 4 51 17 25      | 5         | 2                 |    |                     |                                                                            |                                 | 5 23 16 53      | 3         | 2                 |    |                     |    |                                 |
| 3 34 17 25                                                                  | 3         | 6                 |    |                     |    |                                                                                                                                                                  | 4 22 16 30      | 2         | 3                 |    |                     |                                                                            |                                 | 5 14 17 59      | 3         | 7                 |    |                     |    |                                 |
| 3 03 15 36                                                                  | 0         | 1                 |    |                     |    |                                                                                                                                                                  | 4 24 18 50      | 3         | 6                 |    |                     |                                                                            |                                 | 5 00 15 24      | 2         | 3                 |    |                     |    |                                 |
| 3 46 14 16                                                                  | ...       | ...               |    |                     |    | II.                                                                                                                                                              | 4 03 16 51      | 1         | 3                 |    |                     |                                                                            | II.                             | 5 52 18 16      | 3         | 4                 |    |                     |    | II.                             |
| 3 32 17 29                                                                  | 2         | 0                 |    |                     |    |                                                                                                                                                                  | 4 32 16 59      | 4         | 4                 |    |                     |                                                                            |                                 | 5 17 17 44      | 4         | 2                 |    |                     |    |                                 |
| 3 14 18 02                                                                  | 0         | 3                 |    |                     |    |                                                                                                                                                                  | 4 16 16 30      | 3         | 4                 |    |                     |                                                                            |                                 | 5 00 16 01      | 3         | 8                 |    |                     |    |                                 |
| 3 38 16 10                                                                  | 3         | 9                 |    |                     |    |                                                                                                                                                                  | 4 00 17 16      | 3         | 0                 |    |                     |                                                                            |                                 | 5 43 18 33      | 5         | 0                 |    |                     |    |                                 |
| 3 44 16 53                                                                  | 2         | 6                 |    |                     |    | III.                                                                                                                                                             | 4 49 17 27      | 3         | 0                 |    |                     |                                                                            | III.                            | 5 09 16 54      | 6         | 1                 |    |                     |    | III.                            |
| 3 34 17 29                                                                  | 1         | 8                 |    |                     |    |                                                                                                                                                                  | 4 23 16 25      | 3         | 1                 |    |                     |                                                                            |                                 | 5 56 16 53      | 5         | 8                 |    |                     |    |                                 |
| 3 38 15 41                                                                  | 2         | 3                 |    |                     |    |                                                                                                                                                                  | 4 25 16 38      | 5         | 3                 |    |                     |                                                                            |                                 | 5 36 17 06      | 5         | 0                 |    |                     |    |                                 |
| 3 09 18 09                                                                  | 2         | 5                 |    |                     |    |                                                                                                                                                                  | 4 41 15 38      | 2         | 0                 |    |                     |                                                                            |                                 | 5 40 15 39      | 4         | 2                 |    |                     |    |                                 |
| 3 59 17 48                                                                  | 4         | 0                 |    |                     |    | IV.                                                                                                                                                              | 4 47 17 45      | 3         | 7                 |    |                     |                                                                            | IV.                             | 5 32 ...        | 4         | 5                 |    |                     |    | IV.                             |
| 3 24 16 36                                                                  | 1         | 3                 |    |                     |    |                                                                                                                                                                  | 4 23 15 37      | 2         | 3                 |    |                     |                                                                            |                                 | 5 16 15 44      | 3         | 7                 |    |                     |    |                                 |
| 3 24 17 33                                                                  | 3         | 9                 |    |                     |    |                                                                                                                                                                  | 4 08 17 49      | 2         | 6                 |    |                     |                                                                            |                                 | 5 33 16 53      | 4         | 8                 |    |                     |    |                                 |
| 3 00 16 55                                                                  | 2         | 4                 |    |                     |    |                                                                                                                                                                  | 4 52 17 49      | 2         | 2                 |    |                     |                                                                            |                                 | 5 43 17 26      | 4         | 5                 |    |                     |    |                                 |
| 3 52 17 02                                                                  | 2         | 5                 |    |                     |    | IV.                                                                                                                                                              | 4 13 ...        | 4         | 0                 |    |                     |                                                                            | IV.                             | 5 11 14 53      | 3         | 0                 |    |                     |    | IV.                             |
| 3 30 16 54                                                                  | 3         | 2                 |    |                     |    |                                                                                                                                                                  | 4 56 17 43      | 4         | 4                 |    |                     |                                                                            |                                 | 5 25 16 45      | 2         | 0                 |    |                     |    |                                 |
| 3 33 17 30                                                                  | 1         | 5                 |    |                     |    |                                                                                                                                                                  | 4 22 15 41      | 0         | 0                 |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
| 3 32 16 37                                                                  | -1        | 0                 |    |                     |    |                                                                                                                                                                  | 4 27 15 42      | 1         | 0                 |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
| 3 10 17 03                                                                  | 0         | 5                 |    |                     |    | IV.                                                                                                                                                              | 4 00 16 13      | 2         | 0                 |    |                     |                                                                            | IV.                             |                 |           |                   |    |                     |    | IV.                             |
|                                                                             |           |                   |    |                     |    |                                                                                                                                                                  | 4 51 16 23      | 4         | 0                 |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
|                                                                             |           |                   |    |                     |    |                                                                                                                                                                  |                 |           |                   |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
|                                                                             |           |                   |    |                     |    |                                                                                                                                                                  |                 |           |                   |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
|                                                                             |           |                   |    |                     |    |                                                                                                                                                                  |                 |           |                   |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
| MEANS.                                                                      |           |                   |    |                     |    |                                                                                                                                                                  |                 |           |                   |    |                     |                                                                            |                                 |                 |           |                   |    |                     |    |                                 |
| 3 28 16 56                                                                  | ...       | ...               | 21 |                     |    |                                                                                                                                                                  | 4 27 16 52      | ...       | ...               | 21 |                     |                                                                            |                                 | 5 27 16 55      | ...       | ...               | 17 |                     |    |                                 |
| 3 27 ...                                                                    | 2         | 1                 | 20 |                     |    |                                                                                                                                                                  | 4 27 ...        | 3         | 1                 | 22 |                     |                                                                            |                                 | 5 27 ...        | 4         | 1                 | 18 |                     |    |                                 |
| The low values 14 <sup>h</sup> 16 <sup>m</sup> is rejected, hence new mean— |           |                   |    |                     |    | The high value 18 <sup>h</sup> 50 <sup>m</sup> is in a measure balanced by two low values, 15 <sup>h</sup> 37 <sup>m</sup> and 15 <sup>h</sup> 37 <sup>m</sup> . |                 |           |                   |    |                     | The low value 14 <sup>h</sup> 53 <sup>m</sup> is rejected, hence new mean— |                                 |                 |           |                   |    |                     |    |                                 |
| 3 28 17 04                                                                  | ...       | ...               | 20 |                     |    |                                                                                                                                                                  |                 |           |                   |    |                     |                                                                            |                                 | 5 27 17 02      | ...       | ...               | 16 |                     |    |                                 |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Superior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 6 <sup>h</sup> to 7 <sup>h</sup> .                                          |           |                   |     |                     |      | 7 <sup>h</sup> to 8 <sup>h</sup> .                                         |                 |           |                   |     |                     | 8 <sup>h</sup> to 9 <sup>h</sup> . |                                 |                 |           |                   |    |                     |      |                                 |
|-----------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|------|----------------------------------------------------------------------------|-----------------|-----------|-------------------|-----|---------------------|------------------------------------|---------------------------------|-----------------|-----------|-------------------|----|---------------------|------|---------------------------------|
| Moon's transit.                                                             |           | Lunital interval. |     | Height of L. water. |      | No. of observations and series.                                            | Moon's transit. |           | Lunital interval. |     | Height of L. water. |                                    | No. of observations and series. | Moon's transit. |           | Lunital interval. |    | Height of L. water. |      | No. of observations and series. |
| App. time.                                                                  | L. water. | H.                | M.  | Ft.                 | Dec. |                                                                            | App. time.      | L. water. | H.                | M.  | Ft.                 | Dec.                               |                                 | App. time.      | L. water. | H.                | M. | Ft.                 | Dec. |                                 |
| 6 28                                                                        | 16 45     | 4                 | 7   |                     |      | I.                                                                         | 7 26            | 17 47     | 4                 | 8   |                     |                                    | I.                              | 8 22            | 18 21     | 4                 | 2  |                     |      | I.                              |
| 6 32                                                                        | 17 59     | 5                 | 2   |                     |      |                                                                            | 7 22            | 18 24     | 4                 | 8   |                     |                                    |                                 | 8 11            | 18 50     | 4                 | 5  |                     |      |                                 |
| 6 21                                                                        | 17 55     | 4                 | 9   |                     |      |                                                                            | 7 14            | 18 02     | 4                 | 4   |                     |                                    |                                 | 8 59            | 19 02     | 3                 | 4  |                     |      |                                 |
| 6 01                                                                        | 18 32     | 3                 | 7   |                     |      |                                                                            | 7 34            | 17 38     | 4                 | 2   |                     |                                    |                                 | 8 02            | 18 29     | 5                 | 5  |                     |      |                                 |
| 6 48                                                                        | 17 55     | 3                 | 7   |                     |      |                                                                            | 7 22            | 18 45     | 5                 | 2   |                     |                                    |                                 | 8 48            | 18 43     | 4                 | 2  |                     |      |                                 |
| 6 38                                                                        | 18 00     | 2                 | 9   |                     |      | II.                                                                        | 7 34            | 18 10     | 3                 | 2   |                     |                                    | 8 20                            | 19 22           | 2         | 7                 |    |                     | II.  |                                 |
| 6 01                                                                        | 17 29     | 2                 | 9   |                     |      |                                                                            | 7 40            | 19 06     | 4                 | 1   |                     |                                    | 8 04                            | 18 03           | 5         | 3                 |    |                     |      |                                 |
| 6 47                                                                        | 18 28     | 12                | 4   |                     |      |                                                                            | 7 42            | 18 27     | 4                 | 8   |                     |                                    | 8 46                            | 18 50           | 1         | 8                 |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            | 7 17            | 19 11     | 5                 | 5   |                     |                                    | 8 23                            | 17 36           | 1         | 8                 |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            |                 |           |                   |     |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 6 28                                                                        | 17 18     | 3                 | 8   |                     |      | III.                                                                       | 7 41            | 17 36     | 4                 | 0   |                     |                                    | 8 02                            | 19 13           | 3         | 3                 |    |                     | III. |                                 |
| 6 27                                                                        | 20 01     | 6                 | 0   |                     |      |                                                                            | 7 38            | 18 26     | 3                 | 6   |                     |                                    | 8 50                            | 19 55           | 3         | 3                 |    |                     |      |                                 |
| 6 45                                                                        | 17 42     | 4                 | 5   |                     |      |                                                                            | 7 24            | 18 55     | 4                 | 4   |                     |                                    | 8 41                            | 16 36           | 3         | 3                 |    |                     |      |                                 |
| 6 34                                                                        | 18 00     | 5                 | 2   |                     |      |                                                                            | 7 00            | 17 32     | 4                 | 7   |                     |                                    | 8 28                            | 20 07           | 5         | 0                 |    |                     |      |                                 |
| 6 04                                                                        | 17 25     | 4                 | 6   |                     |      |                                                                            | 7 44            | 18 48     | 4                 | 0   |                     |                                    | 8 42                            | 19 12           | 5         | 1                 |    |                     |      |                                 |
| 6 49                                                                        | 17 10     | 5                 | 6   |                     |      | IV.                                                                        | 7 33            | 18 41     | 5                 | 2   |                     |                                    | 8 35                            | 18 27           | 4         | 1                 |    |                     | IV.  |                                 |
| 6 17                                                                        | 16 54     | 4                 | 4   |                     |      |                                                                            | 7 02            | 18 24     | 4                 | 3   |                     |                                    | 8 25                            | 15 39           | 2         | 7                 |    |                     |      |                                 |
| 6 53                                                                        | ...       | ...               | ... |                     |      |                                                                            | 7 32            | 17 35     | 3                 | 9   |                     |                                    | 8 10                            | 17 24           | 3         | 4                 |    |                     |      |                                 |
| 6 32                                                                        | 18 37     | 3                 | 6   |                     |      |                                                                            | 7 51            | 19 01     | 5                 | 6   |                     |                                    | 8 55                            | 18 09           | 3         | 5                 |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            | 7 38            | 19 01     | 5                 | 6   |                     |                                    | 8 30                            | 18 32           | 3         | 4                 |    |                     |      |                                 |
| 6 28                                                                        | 16 42     | 3                 | 0   |                     |      | V.                                                                         | 7 43            | 17 53     | 5                 | 0   |                     |                                    | 8 16                            | 18 28           | 5         | 8                 |    |                     | V.   |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            | 7 23            | 15 51     | 5                 | 0   |                     |                                    | 8 59                            | 17 59           | 2         | 9                 |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            |                 |           |                   |     |                     |                                    | 8 45                            | 18 25           | 3         | 0                 |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            |                 |           |                   |     |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
|                                                                             |           |                   |     |                     |      |                                                                            |                 |           |                   |     |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| MEANS.                                                                      |           |                   |     |                     |      |                                                                            |                 |           |                   |     |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 6 28                                                                        | 17 49     | ...               | ... | 17                  |      | 7 29                                                                       | 18 17           | ...       | ...               | ... |                     | 8 30                               | 18 15                           | ...             | ...       | 25                |    |                     |      |                                 |
| 6 29                                                                        | ...       | ...               | 4   | 2                   | 18   | 7 29                                                                       | ...             | ...       | 4                 | 6   | 21                  | 8 30                               | ...                             | ...             | 3         | 7                 | 25 |                     |      |                                 |
| The high value 20 <sup>h</sup> 01 <sup>m</sup> is rejected, hence new mean— |           |                   |     |                     |      | The low value 15 <sup>h</sup> 51 <sup>m</sup> is rejected, hence new mean— |                 |           |                   |     |                     |                                    |                                 |                 |           |                   |    |                     |      |                                 |
| 6 28                                                                        | 17 42     | ...               | ... | 16                  |      | 7 29                                                                       | 18 24           | ...       | ...               | ... | 20                  |                                    |                                 |                 |           |                   |    |                     |      |                                 |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Superior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 9 <sup>h</sup> to 10 <sup>h</sup> . |           |                   |     |                     |      | 10 <sup>h</sup> to 11 <sup>h</sup> . |                 |           |                   |     |                     | 11 <sup>h</sup> to 12 <sup>h</sup> . |                                 |                 |           |                   |     |                     |      |                                 |
|-------------------------------------|-----------|-------------------|-----|---------------------|------|--------------------------------------|-----------------|-----------|-------------------|-----|---------------------|--------------------------------------|---------------------------------|-----------------|-----------|-------------------|-----|---------------------|------|---------------------------------|
| Moon's transit.                     |           | Lunital interval. |     | Height of L. water. |      | No. of observations and series.      | Moon's transit. |           | Lunital interval. |     | Height of L. water. |                                      | No. of observations and series. | Moon's transit. |           | Lunital interval. |     | Height of L. water. |      | No. of observations and series. |
| App. time.                          | L. water. |                   |     |                     |      |                                      | App. time.      | L. water. |                   |     |                     |                                      |                                 | App. time.      | L. water. |                   |     |                     |      |                                 |
| H.                                  | M.        | H.                | M.  | Ft.                 | Dec. |                                      | H.              | M.        | H.                | M.  | Ft.                 | Dec.                                 |                                 | H.              | M.        | H.                | M.  | Ft.                 | Dec. |                                 |
| 9 12                                | 18        | 47                | 3   | 1                   |      |                                      | 10 02           | 17        | 57                | 2   | 7                   |                                      |                                 | 11 26           | 17        | 20                | 2   | 7                   |      |                                 |
| 9 47                                | 17        | 59                | 2   | 9                   |      |                                      | 10 36           | 17        | 40                | 1   | 6                   |                                      |                                 | 11 37           | 18        | 53                | 3   | 5                   |      | I.                              |
| 9 31                                | 18        | 00                | 3   | 8                   |      |                                      | 10 13           | 20        | 02                | 2   | 5                   |                                      |                                 | 11 50           | 17        | 51                | —1  | 2                   |      |                                 |
| 9 08                                | 19        | 04                | 2   | 2                   |      | I.                                   | 10 54           | 18        | 36                | 2   | 9                   |                                      | I.                              | 11 41           | 18        | 23                | 5   | 5                   |      |                                 |
| 9 58                                | 18        | 43                | 0   | 7                   |      |                                      | 10 51           | 17        | 50                | 0   | 1                   |                                      |                                 | 11 22           | 19        | 08                | 2   | 3                   |      |                                 |
| 9 27                                | 19        | 09                | 2   | 8                   |      |                                      | 10 10           | 18        | 25                | 2   | 8                   |                                      |                                 | 11 41           | 17        | 21                | —0  | 4                   |      | II.                             |
| 9 18                                | 18        | 10                | 1   | 9                   |      |                                      | 10 54           | 19        | 11                | 2   | 4                   |                                      |                                 | 11 19           | 18        | 36                | 2   | 0                   |      |                                 |
| 9 41                                | 19        | 34                | 1   | 5                   |      |                                      | 10 58           | 18        | 19                | 1   | 0                   |                                      |                                 | 11 38           | 19        | 09                | 1   | 0                   |      |                                 |
| 9 45                                | 17        | 52                | 2   | 8                   |      | II.                                  | 10 32           | 18        | 13                | 1   | 8                   |                                      | II.                             | 11 35           | 16        | 59                | 0   | 9                   |      |                                 |
| 9 39                                | 18        | 45                | 3   | 8                   |      |                                      | 10 45           | 18        | 02                | 1   | 0                   |                                      |                                 | 11 05           | 17        | 58                | 2   | 7                   |      |                                 |
| 9 24                                | 18        | 08                | 2   | 5                   |      |                                      | 10 31           | 18        | 23                | 2   | 2                   |                                      |                                 | 11 51           | 18        | 27                | 2   | 4                   |      | III.                            |
| 9 10                                | 18        | 09                | 1   | 8                   |      |                                      | 10 10           | 19        | 22                | 1   | 6                   |                                      |                                 | 11 07           | 18        | 54                | 0   | 6                   |      |                                 |
| 9 56                                | 17        | 38                | 2   | 2                   |      | III.                                 | 10 54           | 17        | 08                | 2   | 6                   |                                      |                                 | 11 19           | 17        | 39                | 2   | 4                   |      |                                 |
| 9 38                                | 19        | 10                | 4   | 0                   |      |                                      | 10 43           | 18        | 21                | 1   | 3                   |                                      |                                 | 11 54           | 17        | 26                | 1   | 2                   |      |                                 |
| 9 18                                | 17        | 13                | 1   | 8                   |      |                                      | 10 21           | 18        | 42                | 2   | 0                   |                                      | III.                            | 11 39           | 17        | 28                | 2   | 0                   |      |                                 |
| 9 44                                | 18        | 14                | 3   | 6                   |      |                                      | 10 10           | 16        | 51                | 1   | 4                   |                                      |                                 | 11 10           | 18        | 02                | —2  | 0                   |      |                                 |
| 9 22                                | 19        | 14                | 5   | 0                   |      |                                      | 10 31           | 17        | 57                | 3   | 6                   |                                      |                                 | 11 59           | 19        | 13                | —0  | 5                   |      | IV.                             |
| 9 41                                | 18        | 34                | 0   | 0                   |      | IV.                                  | 10 47           | 17        | 38                | 1   | 2                   |                                      |                                 | 11 08           | 17        | 07                | 0   | 0                   |      |                                 |
|                                     |           |                   |     |                     |      |                                      | 10 09           | 18        | 58                | 2   | 0                   |                                      |                                 | 11 53           | 16        | 2                 | 0   | 0                   |      |                                 |
|                                     |           |                   |     |                     |      |                                      | 10 55           | 18        | 12                | 4   | 0                   |                                      |                                 |                 |           |                   |     |                     |      |                                 |
|                                     |           |                   |     |                     |      |                                      | 10 20           | 18        | 21                | 0   | 0                   |                                      | IV.                             |                 |           |                   |     |                     |      |                                 |
|                                     |           |                   |     |                     |      |                                      | 10 24           | 18        | 51                | 1   | 0                   |                                      |                                 |                 |           |                   |     |                     |      |                                 |
| MEANS.                              |           |                   |     |                     |      |                                      |                 |           |                   |     |                     |                                      |                                 |                 |           |                   |     |                     |      |                                 |
| 9 32                                | 18        | 28                | ... | ...                 | 18   |                                      | 10 32           | 18        | 19                | ... | ...                 | 22                                   |                                 | 11 32           | 18        | 01                | ... | ...                 | 19   |                                 |
| 9 32                                | ...       | ...               | 2   | 6                   | 18   |                                      | 10 32           | ...       | ...               | 1   | 9                   | 22                                   |                                 | 11 32           | ...       | ...               | 1   | 3                   | 19   |                                 |

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 0 <sup>h</sup> to 1 <sup>h</sup> . |           |                   |    |                     |    |                                 | 1 <sup>h</sup> to 2 <sup>h</sup> . |           |                   |     |                     |    |                                 | 2 <sup>h</sup> to 3 <sup>h</sup> . |           |                   |     |                     |    |                                 |
|------------------------------------|-----------|-------------------|----|---------------------|----|---------------------------------|------------------------------------|-----------|-------------------|-----|---------------------|----|---------------------------------|------------------------------------|-----------|-------------------|-----|---------------------|----|---------------------------------|
| Moon's transit.                    |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series. | Moon's transit.                    |           | Lunital interval. |     | Height of L. water. |    | No. of observations and series. | Moon's transit.                    |           | Lunital interval. |     | Height of L. water. |    | No. of observations and series. |
| App. time.                         | L. water. | H.                | M. | H.                  | M. |                                 | App. time.                         | L. water. | H.                | M.  | H.                  | M. |                                 | App. time.                         | L. water. | H.                | M.  | H.                  | M. |                                 |
| 0 35                               | 17 25     | 1                 | 8  |                     |    | I.                              | 1 18                               | 17 27     | 1                 | 6   |                     |    | I.                              | 2 02                               | 15 43     | 5                 | 7   |                     |    | I.                              |
| 0 48                               | 18 28     | 0                 | 1  |                     |    |                                 | 1 46                               | 19 00     | 1                 | 5   |                     |    |                                 | 2 48                               | 16 57     | 2                 | 8   |                     |    |                                 |
| 0 44                               | 18 16     | 1                 | 3  |                     |    |                                 | 1 31                               | 17 44     | -0                | 1   |                     |    |                                 | 2 47                               | 17 14     | 1                 | 6   |                     |    |                                 |
| 0 21                               | 18 05     | -0                | 3  |                     |    |                                 | 1 25                               | 17 45     | 0                 | 0   |                     |    |                                 | 2 20                               | 16 54     | 1                 | 9   |                     |    |                                 |
| 0 06                               | 16 58     | 3                 | 4  |                     |    |                                 | 1 44                               | 17 19     | ...               | ... |                     |    |                                 | 2 30                               | 18 10     | -0                | 1   |                     |    |                                 |
| 0 55                               | 17 08     | 2                 | 7  |                     |    |                                 |                                    |           |                   |     |                     |    |                                 | 2 34                               | 17 58     | ...               | ... |                     |    |                                 |
| 0 31                               | 19 31     | -1                | 8  |                     |    | II.                             | 1 27                               | 18 19     | -0                | 4   |                     |    | II.                             | 2 20                               | 17 56     | 1                 | 5   |                     |    | II.                             |
| 0 33                               | 18 13     | 2                 | 4  |                     |    |                                 | 1 21                               | 17 25     | 3                 | 2   |                     |    |                                 | 2 06                               | 17 40     | 2                 | 2   |                     |    |                                 |
| 0 07                               | 17 55     | -0                | 9  |                     |    |                                 | 1 38                               | 18 43     | 0                 | 7   |                     |    |                                 | 2 51                               | 16 25     | 3                 | 9   |                     |    |                                 |
| 0 57                               | 18 05     | 1                 | 1  |                     |    |                                 | 1 14                               | 18 27     | 1                 | 3   |                     |    |                                 | 2 31                               | 18 47     | 1                 | 9   |                     |    |                                 |
| 0 06                               | 18 15     | 2                 | 3  |                     |    |                                 | 1 59                               | 18 57     | 3                 | 3   |                     |    |                                 | 2 26                               | 18 56     | 1                 | 6   |                     |    |                                 |
| 0 52                               | 19 29     | 3                 | 2  |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |
| 0 29                               | 17 56     | -0                | 2  |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |
| 0 00                               | 17 02     | 2                 | 2  |                     |    | III.                            | 1 33                               | 16 00     | 1                 | 5   |                     |    | III.                            | 2 20                               | 14 57     | 1                 | 7   |                     |    | III.                            |
| 0 45                               | 18 18     | 2                 | 0  |                     |    |                                 | 1 04                               | 15 44     | 2                 | 3   |                     |    |                                 | 2 01                               | 17 33     | 1                 | 7   |                     |    |                                 |
| 0 15                               | 16 03     | 0                 | 5  |                     |    |                                 | 1 54                               | 17 24     | 1                 | 0   |                     |    |                                 | 2 44                               | 16 04     | 2                 | 5   |                     |    |                                 |
| 0 43                               | 17 48     | 1                 | 6  |                     |    |                                 | 1 49                               | 18 41     | 0                 | 2   |                     |    |                                 | 2 52                               | 16 38     | 1                 | 6   |                     |    |                                 |
| 0 35                               | 17 52     | 2                 | 4  |                     |    |                                 | 1 24                               | 18 03     | 3                 | 0   |                     |    |                                 | 2 13                               | 17 14     | 2                 | 5   |                     |    |                                 |
| 0 27                               | 17 48     | 1                 | 5  |                     |    |                                 | 1 31                               | 17 24     | 1                 | 0   |                     |    |                                 | 2 31                               | 17 09     | 1                 | 0   |                     |    |                                 |
|                                    |           |                   |    |                     |    |                                 |                                    |           |                   |     |                     |    |                                 | 2 26                               | 17 28     | 2                 | 0   |                     |    |                                 |
| 0 47                               | 16 45     | -1                | 7  |                     |    | IV.                             | 1 36                               | 18 20     | 1                 | 0   |                     |    | IV.                             | 2 24                               | 17 09     | -1                | 0   |                     |    | IV.                             |
| 0 00                               | 17 07     | 1                 | 0  |                     |    |                                 | 1 29                               | 17 39     | 1                 | 0   |                     |    |                                 | 2 15                               | 17 53     | 0                 | 0   |                     |    |                                 |
| 0 45                               | 17 53     | 0                 | 0  |                     |    |                                 | 1 09                               | 19 03     | -1                | 0   |                     |    |                                 | 2 45                               | 15 28     | 0                 | 0   |                     |    |                                 |
| 0 22                               | 18 20     | 1                 | 0  |                     |    |                                 | 1 57                               | 16 46     | 0                 | 0   |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |
| 0 17                               | 16 58     | 0                 | 0  |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |                                    |           |                   |     |                     |    |                                 |

## MEANS.

0 30 17 50 ... 24  
0 30 ... 1 1 24

The two high and two low values of the intervals nearly balance in the mean.

The value 15<sup>h</sup> 44<sup>m</sup> is rejected, hence new mean—

1 34 17 58 ... 20

The lowest value 14<sup>h</sup> 33<sup>m</sup> is rejected, hence—

2 28 17 15 ... 20

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 3 <sup>h</sup> to 4 <sup>h</sup> . |           |                   |    |                     |    |                                 | 4 <sup>h</sup> to 5 <sup>h</sup> . |           |                   |    |                     |    |                                 | 5 <sup>h</sup> to 6 <sup>h</sup> . |           |                   |    |                     |    |                                 |
|------------------------------------|-----------|-------------------|----|---------------------|----|---------------------------------|------------------------------------|-----------|-------------------|----|---------------------|----|---------------------------------|------------------------------------|-----------|-------------------|----|---------------------|----|---------------------------------|
| Moon's transit.                    |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series. | Moon's transit.                    |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series. | Moon's transit.                    |           | Lunital interval. |    | Height of L. water. |    | No. of observations and series. |
| App. time.                         | L. water. | H.                | M. | H.                  | M. |                                 | App. time.                         | L. water. | H.                | M. | H.                  | M. |                                 | App. time.                         | L. water. | H.                | M. | H.                  | M. |                                 |
| 3 36                               | 17 40     | 3                 | 4  |                     |    | I.                              | 4 25                               | 16 06     | 3                 | 9  |                     |    | I.                              | 5 16                               | 15 15     | 4                 | 5  |                     |    | I.                              |
| 3 50                               | 16 56     | 1                 | 8  |                     |    |                                 | 4 52                               | 17 39     | 2                 | 6  |                     |    |                                 | 5 52                               | 18 24     | 3                 | 5  |                     |    |                                 |
| 3 09                               | 17 05     | 2                 | 6  |                     |    |                                 | 4 49                               | 15 55     | 5                 | 1  |                     |    |                                 | 5 37                               | 16 51     | 6                 | 6  |                     |    |                                 |
| 3 59                               | 16 00     | 3                 | 2  |                     |    |                                 | 4 31                               | 17 08     | 1                 | 0  |                     |    |                                 | 5 26                               | 18 13     | 1                 | 0  |                     |    |                                 |
| 3 32                               | 17 37     | 1                 | 6  |                     |    |                                 | 4 09                               | 16 22     | 4                 | 5  |                     |    |                                 | 5 39                               | 17 51     | 3                 | 1  |                     |    |                                 |
| 3 22                               | 17 10     | 1                 | 4  |                     |    | II.                             | 4 54                               | 16 22     | 5                 | 1  |                     |    | II.                             | 5 21                               | 18 55     | 3                 | 8  |                     |    | II.                             |
| 3 08                               | 17 53     | 2                 | 1  |                     |    |                                 | 4 38                               | 16 53     | 2                 | 2  |                     |    |                                 | 5 16                               | 16 00     | 5                 | 5  |                     |    |                                 |
| 3 54                               | 18 07     | 0                 | 3  |                     |    |                                 | 4 24                               | 18 22     | 4                 | 5  |                     |    |                                 | 5 32                               | 17 02     | 4                 | 1  |                     |    |                                 |
| 3 37                               | 17 24     | 2                 | 7  |                     |    |                                 | 4 00                               | 16 48     | 1                 | 0  |                     |    |                                 | 5 11                               | 17 01     | 4                 | 2  |                     |    |                                 |
| 3 15                               | 17 48     | 1                 | 5  |                     |    |                                 | 4 46                               | 17 02     | 3                 | 9  |                     |    |                                 | 5 10                               | 17 30     | 1                 | 8  |                     |    |                                 |
| 3 18                               | 16 34     | 2                 | 7  |                     |    | III.                            | 4 50                               | 16 13     | 6                 | 5  |                     |    | III.                            | 5 09                               | 17 08     | 4                 | 8  |                     |    | III.                            |
| 3 09                               | 15 54     | 3                 | 7  |                     |    |                                 | 4 09                               | 16 55     | 1                 | 8  |                     |    |                                 | 5 54                               | 16 08     | 5                 | 2  |                     |    |                                 |
| 3 59                               | 16 34     | 4                 | 3  |                     |    |                                 | 4 22                               | 17 40     | 3                 | 6  |                     |    |                                 | 5 40                               | 15 20     | 2                 | 8  |                     |    |                                 |
| 3 05                               | 16 59     | 1                 | 8  |                     |    |                                 | 4 49                               | 16 56     | 2                 | 5  |                     |    |                                 | 5 12                               | 18 14     | 3                 | 8  |                     |    |                                 |
| 3 34                               | 16 59     | 3                 | 5  |                     |    |                                 | 4 30                               | 16 27     | 5                 | 0  |                     |    |                                 | 5 55                               | 17 01     | 6                 | 9  |                     |    |                                 |
| 3 53                               | 17 07     | 1                 | 3  |                     |    | IV.                             | 4 34                               | 17 05     | 4                 | 8  |                     |    | IV.                             | 5 19                               | 16 35     | 6                 | 1  |                     |    | IV.                             |
| 3 00                               | 15 27     | 2                 | 0  |                     |    |                                 | 4 46                               | 14 18     | 0                 | 0  |                     |    |                                 | 5 57                               | 15 13     | 3                 | 0  |                     |    |                                 |
| 3 46                               | 15 41     | 3                 | 8  |                     |    |                                 | 4 56                               | 16 13     | 2                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 26                               | 17 44     | 1                 | 8  |                     |    |                                 | 4 25                               | 15 48     | 2                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 09                               | 17 45     | 3                 | 2  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 51                               | 16 33     | 4                 | 1  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 10                               | 17 23     | 0                 | 0  |                     |    | IV.                             |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 57                               | 16 03     | 0                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 06                               | 17 03     | 0                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 59                               | 16 10     | 0                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |
| 3 35                               | 16 38     | 0                 | 0  |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |                                    |           |                   |    |                     |    |                                 |

## MEANS.

3 31 16 56 ... 26  
3 31 ... 2 0 26

4 34 16 38 ... 19  
4 34 ... 3 3 19

5 30 16 59 ... 17  
5 30 ... 4 2 17

The value 14<sup>h</sup> 18<sup>m</sup> is rejected,  
hence new mean—

4 34 16 45 ... 18

The three highest and three lowest values of the interval's balance in the mean.

TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, and October 22, 1854.

| 6 <sup>h</sup> to 7 <sup>h</sup> .                                          |           |                   |     |                     |    |                                 | 7 <sup>h</sup> to 8 <sup>h</sup> .                                          |           |                   |     |                     |    |                                 | 8 <sup>h</sup> to 9 <sup>h</sup> .                                         |           |                   |     |                     |    |                                 |
|-----------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|----|---------------------------------|-----------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|----|---------------------------------|----------------------------------------------------------------------------|-----------|-------------------|-----|---------------------|----|---------------------------------|
| Moon's transit.                                                             |           | Lunital interval. |     | Height of L. water. |    | No. of observations and series. | Moon's transit.                                                             |           | Lunital interval. |     | Height of L. water. |    | No. of observations and series. | Moon's transit.                                                            |           | Lunital interval. |     | Height of L. water. |    | No. of observations and series. |
| App. time.                                                                  | L. water. | H.                | M.  | H.                  | M. |                                 | App. time.                                                                  | L. water. | H.                | M.  | H.                  | M. |                                 | App. time.                                                                 | L. water. | H.                | M.  | H.                  | M. |                                 |
| 6 57 18                                                                     | 46        | 4                 | 4   |                     |    | I.                              | 7 54 17                                                                     | 49        | 4                 | 0   |                     |    | I.                              | 8 47 18                                                                    | 27        | 3                 | 7   |                     |    | I.                              |
| 6 07 16                                                                     | 39        | 5                 | 2   |                     |    |                                 | 7 46 17                                                                     | 00        | 5                 | 5   |                     |    |                                 | 8 35 19                                                                    | 11        | 5                 | 1   |                     |    |                                 |
| 6 57 17                                                                     | 49        | 6                 | 1   |                     |    |                                 | 7 38 17                                                                     | 08        | 4                 | 3   |                     |    |                                 | 8 25 18                                                                    | 21        | 2                 | 3   |                     |    |                                 |
| 6 48 17                                                                     | 58        | 4                 | 0   |                     |    |                                 | 7 11 18                                                                     | 31        | 6                 | 9   |                     |    |                                 | 8 44 19                                                                    | 28        | 3                 | 4   |                     |    |                                 |
| 6 25 17                                                                     | 48        | 3                 | 4   |                     |    |                                 | 7 56 18                                                                     | 46        | 4                 | 3   |                     |    |                                 | 8 25 19                                                                    | 11        | 1                 | 7   |                     |    |                                 |
| 6 14 18                                                                     | 54        | 3                 | 5   |                     |    |                                 | 7 00 18                                                                     | 07        | 3                 | 6   |                     |    |                                 | 8 50 19                                                                    | 08        | 2                 | 9   |                     |    |                                 |
| 6 24 17                                                                     | 36        | 4                 | 6   |                     |    |                                 | 7 42 18                                                                     | 25        | 5                 | 3   |                     |    |                                 | 8 26 18                                                                    | 49        | 3                 | 8   |                     |    |                                 |
|                                                                             |           |                   |     |                     |    |                                 | 7 10 17                                                                     | 05        | 4                 | 1   |                     |    |                                 | 8 10 20                                                                    | 36        | 5                 | 7   |                     |    | II.                             |
| 6 06 17                                                                     | 40        | 4                 | 5   |                     |    | II.                             | 7 59 18                                                                     | 45        | 4                 | 8   |                     |    | II.                             | 8 03 20                                                                    | 18        | 3                 | 9   |                     |    |                                 |
| 6 51 16                                                                     | 25        | 3                 | 7   |                     |    |                                 | 7 38 19                                                                     | 08        | 4                 | 7   |                     |    |                                 | 8 53 19                                                                    | 42        | 5                 | 4   |                     |    |                                 |
| 6 10 17                                                                     | 36        | 4                 | 3   |                     |    |                                 | 7 09 21                                                                     | 07        | 4                 | 7   |                     |    |                                 | 8 12 18                                                                    | 12        | 5                 | 3   |                     |    |                                 |
| 6 01 16                                                                     | 41        | 5                 | 7   |                     |    |                                 | 7 11 18                                                                     | 42        | 5                 | 3   |                     |    |                                 |                                                                            |           |                   |     |                     |    |                                 |
| 6 52 17                                                                     | 08        | 5                 | 5   |                     |    |                                 |                                                                             |           |                   |     |                     |    |                                 | 8 07 19                                                                    | 10        | 4                 | 0   |                     |    |                                 |
| 6 17 17                                                                     | 59        | 5                 | 1   |                     |    | III.                            | 7 13 18                                                                     | 18        | 5                 | 0   |                     |    | III.                            | 8 59 19                                                                    | 33        | 1                 | 8   |                     |    | III.                            |
| 6 07 17                                                                     | 57        | 3                 | 0   |                     |    |                                 | 7 14 17                                                                     | 35        | 6                 | 0   |                     |    |                                 | 8 02 17                                                                    | 02        | 5                 | 2   |                     |    |                                 |
| 6 59 20                                                                     | 05        | 3                 | 8   |                     |    |                                 | 7 47 18                                                                     | 47        | 3                 | 7   |                     |    |                                 | 8 48 17                                                                    | 16        | 4                 | 4   |                     |    |                                 |
| 6 38 17                                                                     | 24        | 5                 | 7   |                     |    |                                 | 7 22 18                                                                     | 10        | 6                 | 1   |                     |    |                                 | 8 32 18                                                                    | 47        | 2                 | 5   |                     |    |                                 |
| 6 27 17                                                                     | 02        | 3                 | 2   |                     |    |                                 | 7 11 18                                                                     | 18        | 4                 | 0   |                     |    |                                 | 8 07 19                                                                    | 55        | 4                 | 3   |                     |    |                                 |
| 6 39 17                                                                     | 47        | 6                 | 5   |                     |    |                                 | 7 54 19                                                                     | 35        | 4                 | 4   |                     |    |                                 | 8 54 17                                                                    | 53        | 4                 | 0   |                     |    |                                 |
| 6 31 18                                                                     | 53        | 4                 | 8   |                     |    |                                 | 7 26 18                                                                     | 30        | 6                 | 0   |                     |    |                                 | 8 37 18                                                                    | 22        | 3                 | 0   |                     |    |                                 |
| 6 07 18                                                                     | 47        | 5                 | 7   |                     |    |                                 | 7 16 18                                                                     | 08        | 4                 | 4   |                     |    |                                 | 8 18 18                                                                    | 37        | 5                 | 6   |                     |    |                                 |
|                                                                             |           |                   |     |                     |    |                                 |                                                                             |           |                   |     |                     |    |                                 | 8 01 17                                                                    | 53        | 4                 | 5   |                     |    |                                 |
| 6 59 17                                                                     | 11        | 4                 | 5   |                     |    | IV.                             | 7 17 16                                                                     | 18        | 5                 | 0   |                     |    | IV.                             | 8 08 17                                                                    | 58        | 5                 | 0   |                     |    | IV.                             |
| 6 58 16                                                                     | 16        | 3                 | 0   |                     |    |                                 |                                                                             |           |                   |     |                     |    |                                 | 8 58 18                                                                    | 08        | 5                 | 0   |                     |    |                                 |
|                                                                             |           |                   |     |                     |    |                                 |                                                                             |           |                   |     |                     |    |                                 | 8 34 18                                                                    | 41        | 3                 | 0   |                     |    |                                 |
| MEANS.                                                                      |           |                   |     |                     |    |                                 |                                                                             |           |                   |     |                     |    |                                 |                                                                            |           |                   |     |                     |    |                                 |
| 6 31                                                                        | 17        | 45                | ... | ...                 | 22 |                                 | 7 28                                                                        | 18        | 18                | ... | ...                 | 21 |                                 | 8 29                                                                       | 18        | 41                | ... | ...                 | 24 |                                 |
| 6 31                                                                        | ...       | ...               | 4   | 6                   | 22 |                                 | 7 28                                                                        | ...       | ...               | 4   | 8                   | 21 |                                 | 8 29                                                                       | ...       | ...               | 4   | 0                   | 24 |                                 |
| The high value 20 <sup>h</sup> 05 <sup>m</sup> is rejected, hence new mean— |           |                   |     |                     |    |                                 | The high value 21 <sup>h</sup> 07 <sup>m</sup> is rejected, hence new mean— |           |                   |     |                     |    |                                 | The low value 15 <sup>h</sup> 58 <sup>m</sup> is rejected, hence new mean— |           |                   |     |                     |    |                                 |
| 6 30                                                                        | 17        | 39                | ... | ...                 | 21 |                                 | 7 29                                                                        | 18        | 10                | ... | ...                 | 20 |                                 | 8 30                                                                       | 18        | 48                | ... | ...                 | 23 |                                 |



TABLE FOR THE REDUCTION OF TIDES.—No. 2.

Showing the Interval between the App. Time of the Moon's Inferior Transit and the Time of Low Water, and also the Heights of Low Water, at Van Rensselaer Harbor, from Four Series of Observations made between October 10, 1853, to October 22, 1855.

| 9 <sup>h</sup> to 10 <sup>h</sup> .                                            |     |                   |     |                     |      | 10 <sup>h</sup> to 11 <sup>h</sup> .                                                                                                                                      |                                                                                                                                                                          |       |                   |     |                     | 11 <sup>h</sup> to 12 <sup>h</sup> . |                                 |                      |     |                   |     |                     |      |                                 |     |
|--------------------------------------------------------------------------------|-----|-------------------|-----|---------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------------------|-----|---------------------|--------------------------------------|---------------------------------|----------------------|-----|-------------------|-----|---------------------|------|---------------------------------|-----|
| Moon's transit.                                                                |     | Lunital interval. |     | Height of L. water. |      | No. of observations and series.                                                                                                                                           | Moon's transit.                                                                                                                                                          |       | Lunital interval. |     | Height of L. water. |                                      | No. of observations and series. | Moon's transit.      |     | Lunital interval. |     | Height of L. water. |      | No. of observations and series. |     |
| App. time. L. water.                                                           |     |                   |     |                     |      |                                                                                                                                                                           | App. time. L. water.                                                                                                                                                     |       |                   |     |                     |                                      |                                 | App. time. L. water. |     |                   |     |                     |      |                                 |     |
| H.                                                                             | M.  | H.                | M.  | Ft.                 | Dec. | I.                                                                                                                                                                        | H.                                                                                                                                                                       | M.    | H.                | M.  | Ft.                 | Dec.                                 | I.                              | H.                   | M.  | H.                | M.  | Ft.                 | Dec. | I.                              |     |
| 9 37                                                                           | 18  | 37                | 2   | 7                   |      |                                                                                                                                                                           | 10 11                                                                                                                                                                    | 19    | 05                | 3   | 9                   |                                      |                                 | 11 01                | 18  | 00                | 1   | 9                   |      |                                 |     |
| 9 23                                                                           | 18  | 53                | 4   | 9                   |      |                                                                                                                                                                           | 10 34                                                                                                                                                                    | 18    | 26                | 2   | 1                   |                                      |                                 | 11 52                | 19  | 09                | 3   | 6                   |      |                                 |     |
| 9 09                                                                           | 19  | 07                | 2   | 8                   |      |                                                                                                                                                                           | 10 24                                                                                                                                                                    | 17    | 47                | 1   | 2                   |                                      |                                 | 11 15                | 18  | 15                | 0   | 7                   |      |                                 |     |
| 9 52                                                                           | 18  | 54                | 2   | 6                   |      |                                                                                                                                                                           | 10 31                                                                                                                                                                    | 18    | 04                | 2   | 3                   |                                      |                                 | 11 59                | 17  | 01                | 0   | 4                   |      |                                 |     |
| 9 33                                                                           | 19  | 08                | 2   | 6                   |      |                                                                                                                                                                           | 10 06                                                                                                                                                                    | 18    | 54                | 1   | 3                   |                                      |                                 | 11 20                | 18  | 06                | 1   | 7                   |      |                                 |     |
| 9 06                                                                           | 19  | 00                | 0   | 3                   |      |                                                                                                                                                                           | 10 57                                                                                                                                                                    | 18    | 03                | 2   | 8                   |                                      |                                 | 11 17                | 17  | 48                | 2   | 4                   |      |                                 |     |
| 9 49                                                                           | 18  | 16                | 3   | 5                   |      |                                                                                                                                                                           | 10 15                                                                                                                                                                    | 18    | 02                | 2   | 0                   |                                      |                                 | 11 30                | 18  | 47                | 2   | 6                   |      |                                 |     |
| 9 46                                                                           | 19  | 12                | 4   | 9                   |      |                                                                                                                                                                           | 10 05                                                                                                                                                                    | 18    | 34                | 3   | 4                   |                                      |                                 | 11 46                | 17  | 59                | 0   | 7                   |      |                                 |     |
| 9 15                                                                           | 21  | 00                | 3   | 7                   |      |                                                                                                                                                                           | 10 55                                                                                                                                                                    | 18    | 30                | 1   | 3                   |                                      |                                 | 11 13                | 18  | 49                | 3   | 0                   |      |                                 |     |
| 9 12                                                                           | 18  | 35                | 2   | 8                   |      | II. <td>10 32</td> <td>18</td> <td>32</td> <td>1</td> <td>8</td> <td></td> <td>11 43</td> <td>18</td> <td>42</td> <td>-1</td> <td>3</td> <td></td> <td></td> <td>II.</td> | 10 32                                                                                                                                                                    | 18    | 32                | 1   | 8                   |                                      | 11 43                           | 18                   | 42  | -1                | 3   |                     |      | II.                             |     |
| 9 11                                                                           | 18  | 43                | 4   | 3                   |      |                                                                                                                                                                           | 10 19                                                                                                                                                                    | 18    | 15                | 1   | 9                   |                                      | 11 16                           | 19                   | 16  | 0                 | 1   |                     |      |                                 |     |
| 9 47                                                                           | 18  | 45                | 1   | 7                   |      |                                                                                                                                                                           | 10 43                                                                                                                                                                    | 18    | 50                | 2   | 0                   |                                      | 11 09                           | 18                   | 40  | 1                 | 0   |                     |      |                                 |     |
| 9 33                                                                           | 20  | 01                | 2   | 0                   |      |                                                                                                                                                                           | 10 38                                                                                                                                                                    | 18    | 23                | 2   | 1                   |                                      | 11 28                           | 19                   | 05  | 3                 | 4   |                     |      |                                 |     |
| 9 16                                                                           | 19  | 03                | 3   | 3                   |      |                                                                                                                                                                           | 10 07                                                                                                                                                                    | 19    | 36                | 2   | 9                   |                                      | 11 38                           | 18                   | 23  | 1                 | 8   |                     |      | III.                            |     |
| 9 59                                                                           | 18  | 19                | 2   | 0                   |      |                                                                                                                                                                           | 10 55                                                                                                                                                                    | 18    | 33                | 2   | 0                   |                                      | 11 44                           | 19                   | 14  | 3                 | 1   |                     |      |                                 |     |
| 9 22                                                                           | 19  | 36                | 3   | 3                   |      |                                                                                                                                                                           | 10 15                                                                                                                                                                    | 18    | 25                | 2   | 4                   |                                      | 11 20                           | 18                   | 05  | 2                 | 2   |                     |      |                                 |     |
| 9 47                                                                           | 20  | 19                | 5   | 0                   |      |                                                                                                                                                                           | IV. <td>10 33</td> <td>17</td> <td>34</td> <td>2</td> <td>0</td> <td></td> <td>11 17</td> <td>15</td> <td>50</td> <td>0</td> <td>0</td> <td></td> <td></td> <td>IV.</td> | 10 33 | 17                | 34  | 2                   | 0                                    |                                 | 11 17                | 15  | 50                | 0   | 0                   |      |                                 | IV. |
| 9 19                                                                           | 18  | 26                | 2   | 0                   |      |                                                                                                                                                                           |                                                                                                                                                                          | 10 45 | 17                | 26  | -1                  | 2                                    |                                 | 11 36                | 17  | 36                | -1  | 0                   |      |                                 |     |
|                                                                                |     |                   |     |                     |      |                                                                                                                                                                           |                                                                                                                                                                          | 10 02 | 17                | 43  | 1                   | 0                                    |                                 | 11 30                | 17  | 45                | 0   | 0                   |      |                                 |     |
|                                                                                |     |                   |     |                     |      | 10 46                                                                                                                                                                     |                                                                                                                                                                          | 17    | 29                | 0   | 0                   |                                      |                                 |                      |     |                   |     |                     |      |                                 |     |
| MEANS.                                                                         |     |                   |     |                     |      |                                                                                                                                                                           |                                                                                                                                                                          |       |                   |     |                     |                                      |                                 |                      |     |                   |     |                     |      |                                 |     |
| 9 30                                                                           | 19  | 06                | ... | ...                 | 18   | 10 20                                                                                                                                                                     |                                                                                                                                                                          | 18    | 19                | ... | ...                 | 20                                   | 11 28                           | 18                   | 14  | ...               | ... | 19                  |      |                                 |     |
| 9 30                                                                           | ... | ...               | 3   | 0                   | 18   | 10 29                                                                                                                                                                     |                                                                                                                                                                          | ...   | ...               | 1   | 9                   | 20                                   | 11 28                           | ...                  | ... | 1                 | 4   | 19                  |      |                                 |     |
| The highest value 21 <sup>h</sup> 00 <sup>m</sup> is rejected, hence new mean— |     |                   |     |                     |      | The low value 15 <sup>h</sup> 50 <sup>m</sup> is rejected, hence new mean—                                                                                                |                                                                                                                                                                          |       |                   |     |                     |                                      |                                 |                      |     |                   |     |                     |      |                                 |     |
| 9 30                                                                           | 19  | 00                | ... | ...                 | 17   | 11 28                                                                                                                                                                     |                                                                                                                                                                          | 18    | 21                | ... | ...                 | 18                                   |                                 |                      |     |                   |     |                     |      |                                 |     |

The preceding tables (No. 2) contain the individual and mean values for interval and height, for high and low water, and the moon's upper and lower transit. The mean, in some cases, was improved by the application of Peirce's criterion for the rejection of doubtful observations; a few other rejections were made, as stated, in order to obtain a well-balanced mean; of 982 observations of the interval, but 17 were thus rejected.

*Half-monthly Inequality.*—For the comparison of the observed with the theoretical values, it is customary to use the forms of the equilibrium theory or of the wave theory,<sup>1</sup> certain modifications being necessary to produce an agreement between these theories with observation. According to the equilibrium theory the formula for the position of the pole of the tidal spheroid is:

$$\tan. 2 \theta' = - \frac{h \sin. 2 \phi}{h' + h \cos. 2 \phi},$$

where  $h$  and  $h'$  are the elevations of the spheroid due to the sun and moon respectively,  $\phi$  the angular distance of the moon from the sun and  $\theta'$  the angular distance of the pole of the spheroid (or of high water) from the moon's place. In reality, however, the pole of this spheroid follows the moon at a certain distance, the mean value  $\lambda'$  of which is known as the "mean establishment" (also fundamental hour, corrected establishment), and which corresponds to a distance of the sun and moon of  $\phi - \alpha$  instead of  $\phi$ . This retroposition of the theoretical tide has been called the age of the tide. For the comparison of the observed and computed values for the half-monthly inequality in time, we have the formula:<sup>2</sup>

$$\tan. 2 (\theta' - \lambda') = - \frac{h \sin. 2 (\phi - \alpha)}{h' + h \cos. 2 (\phi - \alpha)}.$$

This inequality goes through its period twice in each month. Proper values have to be found for the ratio  $\frac{h}{h'}$  and the angle  $\alpha$ .

The observations of 480 *high waters* furnish us with the following values, derived from the preceding tabulation on form No. 2:—

<sup>1</sup> An account of the Equilibrium, Laplace's and the Wave Theories, will be found in the *Encyclopædia of Astronomy*, forming a portion of the *Encyclopædia Metropolitana*, London, 1843; article "On Tides and Waves," by G. B. Airy, Esq., Astronomer Royal.

<sup>2</sup> Phil. Trans. Royal Society, 1834, Part I. On the Empirical Laws of the Tides in the Port of London, with some Reflections on the Theory; by the Rev. W. Whewell.

See also Phil. Trans. Royal Society, 1836, Part I. Researches on the Tides, fourth series: On the Empirical Laws of the Tides in the Port of Liverpool. By the Rev. W. Whewell.

| From C's upper transit.                |                    |                      | From C's lower transit.                |                                 |                      | From C's upper and lower transit.      |                                 |                      |
|----------------------------------------|--------------------|----------------------|----------------------------------------|---------------------------------|----------------------|----------------------------------------|---------------------------------|----------------------|
| Apparent solar time of moon's transit. | Lunital interval.  | No. of observations. | Apparent solar time of moon's transit. | Lunital interval.               | No. of observations. | Apparent solar time of moon's transit. | Lunital interval.               | No. of observations. |
| 0 <sup>h</sup> 29 <sup>m</sup>         | 11 40 <sup>m</sup> | 18                   | 0 <sup>h</sup> 29 <sup>m</sup>         | 11 <sup>h</sup> 34 <sup>m</sup> | 25                   | 0 <sup>h</sup> 29 <sup>m</sup>         | 11 <sup>h</sup> 37 <sup>m</sup> | 43                   |
| 1 29                                   | 11 42              | 22                   | 1 31                                   | 11 15                           | 21                   | 1 30                                   | 11 12                           | 43                   |
| 2 32                                   | 11 04              | 29                   | 2 27                                   | 10 59                           | 29                   | 2 30                                   | 11 01                           | 40                   |
| 3 30                                   | 10 57              | 19                   | 3 31                                   | 10 40                           | 26                   | 3 30                                   | 10 47                           | 45                   |
| 4 27                                   | 10 52              | 21                   | 4 33                                   | 11 01                           | 20                   | 4 30                                   | 10 56                           | 41                   |
| 5 27                                   | 10 53              | 19                   | 5 30                                   | 11 04                           | 17                   | 5 29                                   | 10 58                           | 36                   |
| 6 31                                   | 11 45              | 17                   | 6 33                                   | 12 13                           | 19                   | 6 32                                   | 11 59                           | 36                   |
| 7 28                                   | 12 28              | 20                   | 7 33                                   | 12 28                           | 18                   | 7 30                                   | 12 27                           | 38                   |
| 8 32                                   | 12 42              | 24                   | 8 29                                   | 12 44                           | 21                   | 8 30                                   | 12 43                           | 45                   |
| 9 32                                   | 12 36              | 18                   | 9 30                                   | 12 07                           | 18                   | 9 31                                   | 12 22                           | 36                   |
| 10 32                                  | 12 23              | 20                   | 10 29                                  | 12 18                           | 19                   | 10 30                                  | 12 21                           | 39                   |
| 11 32                                  | 12 17              | 19                   | 11 28                                  | 12 16                           | 19                   | 11 30                                  | 12 16                           | 38                   |
| Mean and sum                           | 11 44              | 237                  | Mean and sum                           | 11 43                           | 243                  | Mean and sum                           | 11 43.3                         | 480                  |

The mean establishment resulting from the observed times of 480 high waters at Van Rensselaer Harbor is therefore 11<sup>h</sup> 43.3<sup>m</sup>, referred to the moon's transit immediately preceding and corresponding to a mean horizontal parallax of the moon and sun, and to the moon's and sun's declination of 16° nearly. The mean interval corresponds to the moon's transit of 0<sup>h</sup> 21<sup>m</sup> nearly, indicating that the epoch would have come out 0<sup>h</sup> 0<sup>m</sup> if transit E (see An Elementary Treatise on the Tides, by J. W. Lubback, Esq., London, 1839) or that immediately preceding transit F had been used.

In like manner we obtain the following table from the observed times of 485 low waters at Van Rensselaer Harbor:—

| From C's upper transit.                |                                 |                      | From C's lower transit.                |                                 |                      | From C's upper and lower transit.      |                                 |                      |
|----------------------------------------|---------------------------------|----------------------|----------------------------------------|---------------------------------|----------------------|----------------------------------------|---------------------------------|----------------------|
| Apparent solar time of moon's transit. | Lunital interval.               | No. of observations. | Apparent solar time of moon's transit. | Lunital interval.               | No. of observations. | Apparent solar time of moon's transit. | Lunital interval.               | No. of observations. |
| 0 <sup>h</sup> 30 <sup>m</sup>         | 17 <sup>h</sup> 43 <sup>m</sup> | 21                   | 0 <sup>h</sup> 30 <sup>m</sup>         | 17 <sup>h</sup> 50 <sup>m</sup> | 24                   | 0 <sup>h</sup> 30 <sup>m</sup>         | 17 <sup>h</sup> 50 <sup>m</sup> | 45                   |
| 1 28                                   | 17 39                           | 22                   | 1 34                                   | 17 58                           | 20                   | 1 31                                   | 17 48                           | 42                   |
| 2 31                                   | 17 43                           | 21                   | 2 28                                   | 17 15                           | 20                   | 2 30                                   | 17 29                           | 41                   |
| 3 28                                   | 17 04                           | 20                   | 3 31                                   | 16 56                           | 26                   | 3 30                                   | 16 59                           | 46                   |
| 4 27                                   | 16 52                           | 21                   | 4 34                                   | 16 45                           | 18                   | 4 30                                   | 16 49                           | 39                   |
| 5 27                                   | 17 02                           | 16                   | 5 30                                   | 16 59                           | 17                   | 5 29                                   | 17 00                           | 33                   |
| 6 28                                   | 17 42                           | 16                   | 6 30                                   | 17 39                           | 21                   | 6 30                                   | 17 40                           | 37                   |
| 7 29                                   | 18 24                           | 20                   | 7 29                                   | 18 10                           | 20                   | 7 29                                   | 18 17                           | 40                   |
| 8 30                                   | 18 15                           | 25                   | 8 29                                   | 18 48                           | 23                   | 8 30                                   | 18 31                           | 48                   |
| 9 32                                   | 18 28                           | 18                   | 9 30                                   | 19 00                           | 17                   | 9 31                                   | 18 43                           | 35                   |
| 10 32                                  | 18 19                           | 22                   | 10 29                                  | 18 19                           | 20                   | 10 30                                  | 18 19                           | 42                   |
| 11 32                                  | 18 01                           | 19                   | 11 28                                  | 18 21                           | 18                   | 11 30                                  | 18 11                           | 37                   |
| Mean and sum                           | 17 46                           | 241                  | Mean and sum                           | 17 50                           | 244                  | Mean and sum                           | 17 48.0                         | 485                  |

The mean establishment resulting from the observed times of 485 low waters is 17<sup>h</sup> 48.0<sup>m</sup>, referred to the moon's transit immediately preceding low water, and the same to which the preceding high water has been referred; the difference between the two mean intervals is 6<sup>h</sup> 04.7<sup>m</sup>.

To obtain a numerical expression for the half-monthly inequality in time, the value for  $\alpha$  should be determined so as to furnish, in particular, good results for

$5^h 30^m$ ,  $6^h 30^m$ ,  $7^h 30^m$ , where the curve is steepest; the value  $\frac{h}{k}$  is obtained from the greatest range of the inequality determined, for a first approximation, by a graphical process. I find from the observed high waters  $\alpha = 0^h 21^m$  or  $5^\circ 15'$ , and from the low waters  $\alpha = 0^h 50^m$  or  $12^\circ 30'$ . Range of inequality, from the high waters,  $1^h 51^m$  or  $27^\circ 48'$ , the *sin.* of which is 0.4649, and for the low waters, range  $1^h 54^m$  or  $28^\circ 30'$ , the *sin.* of which is 0.4771; hence the expression for the half-monthly inequality in time becomes

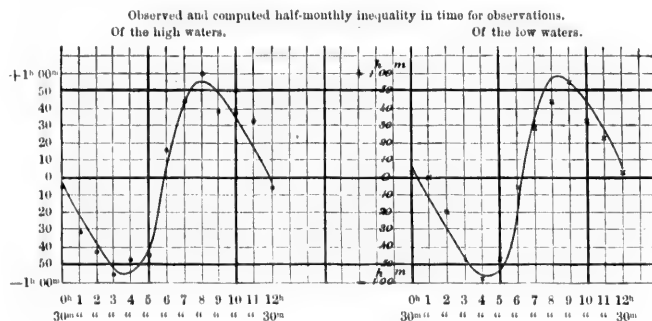
$$\begin{aligned} \text{From the observed high waters } \tan. 2(\theta - 175^\circ 49'.5) &= \frac{0.4649 \sin. 2(\phi - 5^\circ 15')}{1 + 0.4649 \cos. 2(\phi - 5^\circ 15')} \\ \text{" " " low waters } \tan. 2(\theta - 267^\circ 00') &= \frac{0.4771 \sin. 2(\phi - 12^\circ 30')}{1 + 0.4771 \cos. 2(\phi - 12^\circ 30')} \end{aligned}$$

These expressions furnish us with the following comparison:—

HALF-MONTHLY INEQUALITY IN TIME.

| From high waters.                      |                  |                  |                  | From low waters.                       |                  |                  |                  |
|----------------------------------------|------------------|------------------|------------------|----------------------------------------|------------------|------------------|------------------|
| Apparent solar time of moon's transit. | Observed.        | Computed.        | Difference.      | Apparent solar time of moon's transit. | Observed.        | Computed.        | Difference.      |
| $0^h 29^m$                             | — 6 <sup>m</sup> | — 3 <sup>m</sup> | — 3 <sup>m</sup> | $0^h 30^m$                             | + 2 <sup>m</sup> | + 6 <sup>m</sup> | — 4 <sup>m</sup> |
| 1 30                                   | — 31             | — 22             | — 9              | 1 31                                   | 0                | — 13             | + 13             |
| 2 30                                   | — 42             | — 39             | — 3              | 2 30                                   | — 19             | — 31             | + 12             |
| 3 30                                   | — 56             | — 52             | — 4              | 3 30                                   | — 49             | — 47             | — 2              |
| 4 30                                   | — 47             | — 55             | + 8              | 4 30                                   | — 59             | — 55             | — 4              |
| 5 29                                   | — 45             | — 38             | — 7              | 5 29                                   | — 48             | — 52             | + 4              |
| 6 32                                   | + 16             | + 8              | + 8              | 6 30                                   | — 8              | — 18             | + 10             |
| 7 30                                   | + 44             | + 46             | — 2              | 7 29                                   | + 29             | + 33             | — 4              |
| 8 30                                   | + 60             | + 56             | + 4              | 8 30                                   | + 43             | + 56             | — 13             |
| 9 31                                   | + 39             | + 48             | — 9              | 9 31                                   | + 55             | + 54             | + 1              |
| 10 30                                  | + 18             | + 34             | + 4              | 10 30                                  | + 31             | + 42             | — 11             |
| 11 30                                  | + 33             | + 16             | + 17             | 11 30                                  | + 23             | + 25             | — 2              |

Considering that the times of high and low water are only observed to the nearest half hour and for some time to the nearest hour, the agreement as shown above and by the diagrams, seems to be satisfactory.



In the above diagram, the observed values are indicated by dots; the computed values are represented by curves. From the times we have seen the mean value  $\frac{h}{k}$  (or  $\frac{S'}{M'}$  of the wave theory and ( $A$ ) of Lubbock's) = 0.471, and  $\alpha = 0^h 36^m$ ; hence, the age of the tide, or the time requisite for the moon to increase its right ascension by that amount, becomes  $\frac{2}{3}$  days, or 18 hours.

*Half-monthly Inequality in Height.*—The theoretical expression for the half monthly inequality in height of high water is:

$$\eta = \sqrt{\{h^2 + k^2 + 2hk \cos. 2\phi\}^{\frac{1}{2}}}$$

where  $\eta$  expresses the height of the pole of the equilibrium spheroid above the mean level of the surface; for its application, and according to the wave theory, it must be changed to:

$$\eta = \sqrt{\{h^2 + k^2 + 2hk \cos. 2(\phi - \alpha)\}^{\frac{1}{2}}}$$

The following table contains the results of the observations from the high and low waters, and the moon's superior and inferior transit:

| From superior transits.        |                       |         | From inferior transits.        |                       |         | Means.                |         |
|--------------------------------|-----------------------|---------|--------------------------------|-----------------------|---------|-----------------------|---------|
| Moon's transit.                | Height of high water. | Number. | Moon's transit.                | Height of high water. | Number. | Height of high water. | Number. |
| 0 <sup>h</sup> 31 <sup>m</sup> | Feet. 12.1            | 20      | 0 <sup>h</sup> 29 <sup>m</sup> | Feet. 12.2            | 25      | Feet. 12.1            | 15      |
| 1 29                           | 11.6                  | 22      | 1 31                           | 12.3                  | 21      | 11.9                  | 43      |
| 2 29                           | 11.8                  | 20      | 2 27                           | 11.8                  | 19      | 11.8                  | 39      |
| 3 29                           | 10.9                  | 21      | 3 31                           | 11.1                  | 26      | 11.0                  | 47      |
| 4 27                           | 10.5                  | 22      | 4 33                           | 10.5                  | 20      | 10.5                  | 42      |
| 5 27                           | 9.5                   | 20      | 5 30                           | 9.4                   | 18      | 9.5                   | 38      |
| 6 29                           | 9.1                   | 19      | 6 34                           | 9.1                   | 20      | 9.1                   | 39      |
| 7 29                           | 9.1                   | 21      | 7 33                           | 9.6                   | 18      | 9.3                   | 39      |
| 8 32                           | 9.9                   | 24      | 8 30                           | 9.7                   | 23      | 9.8                   | 47      |
| 9 31                           | 10.4                  | 19      | 9 30                           | 10.4                  | 19      | 10.4                  | 38      |
| 10 31                          | 11.1                  | 21      | 10 29                          | 10.9                  | 19      | 11.0                  | 40      |
| 11 32                          | 11.7                  | 19      | 11 28                          | 11.5                  | 19      | 11.6                  | 38      |
|                                |                       | 248     |                                |                       | 247     | 10.67                 | 495     |

| From superior transits.        |                      |         | From inferior transits.        |                      |         | Means.               |         |
|--------------------------------|----------------------|---------|--------------------------------|----------------------|---------|----------------------|---------|
| Moon's transit.                | Height of low water. | Number. | Moon's transit.                | Height of low water. | Number. | Height of low water. | Number. |
| 0 <sup>h</sup> 30 <sup>m</sup> | Feet. 1.7            | 21      | 0 <sup>h</sup> 30 <sup>m</sup> | Feet. 1.1            | 24      | Feet. 1.4            | 45      |
| 1 29                           | 1.3                  | 23      | 1 33                           | 1.1                  | 20      | 1.2                  | 43      |
| 2 30                           | 1.7                  | 20      | 2 28                           | 1.7                  | 20      | 1.7                  | 40      |
| 3 27                           | 2.1                  | 20      | 3 31                           | 2.0                  | 26      | 2.0                  | 46      |
| 4 27                           | 3.1                  | 22      | 4 34                           | 3.3                  | 19      | 3.2                  | 41      |
| 5 27                           | 4.1                  | 18      | 5 30                           | 4.2                  | 17      | 4.1                  | 35      |
| 6 29                           | 4.2                  | 18      | 6 31                           | 4.5                  | 22      | 4.4                  | 40      |
| 7 29                           | 4.6                  | 21      | 7 28                           | 4.8                  | 21      | 4.7                  | 42      |
| 8 30                           | 3.7                  | 25      | 8 29                           | 4.0                  | 24      | 3.8                  | 49      |
| 9 32                           | 2.6                  | 18      | 9 30                           | 3.0                  | 18      | 2.8                  | 36      |
| 10 32                          | 1.9                  | 22      | 10 29                          | 1.9                  | 20      | 1.9                  | 42      |
| 11 32                          | 1.3                  | 19      | 11 28                          | 1.4                  | 19      | 1.4                  | 38      |
|                                |                      | 247     |                                |                      | 250     | 2.72                 | 497     |

<sup>1</sup> See Phil. Trans. Royal Soc., 1834 and 1836.

<sup>2</sup> Encyclopædia Metropolitana, Tides and Waves, Art. (535). The expression given by Mr. Lubbock is:

$$h = D + (E) \left\{ \left( 1 + \frac{D}{c} \right) (A) \cos. (2\phi - 2\alpha) + \left( 1 + \frac{D'}{c} \right) \cos. 2\phi \right\};$$

for which see his treatise

The values for  $k$ ,  $h$  and  $a$  were found from the maxima and minima values of the inequality, viz., for the high water:

$$y = \sqrt{10.6^2 + 1.5^2 + 31.8 \cos. 2(\phi - 15^\circ)};$$

for the low waters:

$$y' = \sqrt{2.95^2 + 1.75^2 - 5.16 \cos. 2(\phi - 15^\circ)};$$

These expressions may be changed to

$$y = 10.6 + 1.5 \cos. 2(\phi - 15^\circ), \text{ and } y' = 2.7 - 1.7 \cos. 2(\phi - 15^\circ);$$

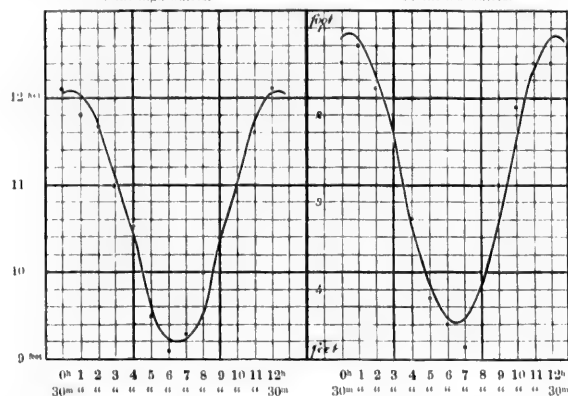
they leave the following differences between the computed and observed values:—

| Moon's transit.                | Height of high water. |           |             | Height of low water. |           |             |
|--------------------------------|-----------------------|-----------|-------------|----------------------|-----------|-------------|
|                                | Computed.             | Observed. | Difference. | Computed.            | Observed. | Difference. |
| 0 <sup>h</sup> 30 <sup>m</sup> | 12.1                  | 12.1      | 0.0         | 1.1                  | 1.4       | +0.3        |
| 1 30                           | 12.0                  | 11.9      | -0.1        | 1.1                  | 1.2       | +0.1        |
| 2 30                           | 11.7                  | 11.8      | +0.1        | 1.5                  | 1.7       | +0.2        |
| 3 30                           | 11.0                  | 11.0      | 0.0         | 2.3                  | 2.0       | -0.3        |
| 4 30                           | 10.2                  | 10.5      | +0.3        | 3.1                  | 3.2       | +0.1        |
| 5 30                           | 9.5                   | 9.5       | 0.0         | 3.9                  | 4.1       | +0.2        |
| 6 30                           | 9.1                   | 9.1       | 0.0         | 4.3                  | 4.4       | +0.1        |
| 7 30                           | 9.2                   | 9.3       | +0.1        | 4.3                  | 4.7       | +0.4        |
| 8 30                           | 9.5                   | 9.8       | +0.3        | 3.9                  | 3.8       | -0.1        |
| 9 30                           | 10.2                  | 10.4      | +0.2        | 3.1                  | 2.8       | -0.3        |
| 10 30                          | 11.0                  | 11.0      | 0.0         | 2.3                  | 1.9       | -0.4        |
| 11 30                          | 11.7                  | 11.6      | -0.1        | 1.5                  | 1.4       | -0.1        |

The differences may be considered within the uncertainty of the observations.

The annexed diagram shows the comparison given above:—

Observed and computed half-monthly inequality in height from observations.  
Of the high waters.                      Of the low waters.



From the inequality in height  $\frac{h}{k}$  or  $\frac{S''}{M''}$  (notation of the wave theory) = 0.367  
whereas from the inequality in times  $\frac{h}{k}$  or  $\frac{S''}{M''}$  . . . . . = 0.471

The ratio<sup>1</sup> of the solar to the lunar tide is deduced with more exactness from the inequality in times, and the above value is certainly greater than the average value deduced at more southern stations. One of the reasons why this ratio is not constant, and which probably applies here, is given in (538,  $\beta$ ) ('Tides and Waves'), viz.: If tides are communicated by different channels to the same port, the proportion of the solar and lunar waves will depend on the length of those channels. This explanation would require a polar tide to enter through Kennedy Channel, to combine with the principal tide which passes up Baffin's Bay, and enters by Smith's Straits. According to the equilibrium theory, there should be no tide at the pole, and but a small tide in latitude  $78\frac{1}{2}^\circ$ ; but it is the tide wave propagated from the Atlantic, which is felt in this part of the polar regions. With regard to  $\alpha$ , its value as found by the heights is more accurate than that found by the times; the latter gave  $\alpha = 9^\circ$ , the former  $15^\circ$  (the same from high and low waters). Adopting  $15^\circ$ , the retard or age of the tide becomes  $1\frac{1}{2}$  day, by which interval the spring and neap tides follow the syzygies and quadratures, respectively. The time-value of  $\alpha$  is here smaller than the height-value, which is more in accordance with theory than the opposite, as observed at a number of places on the coast of England (543 and 546, Tides and Waves). Compared with other values of  $\alpha$ , the Van Rensselaer value appears somewhat smaller than an average at more southern stations.

We have further, mean rise and fall of tides at Van Rensselaer Bay 7.9 feet, range of spring tides 11.1 feet, and range of neap tides 4.7 feet. These numbers are averages from the discussions of  $9\frac{1}{2}$  lunations, and obtain without regard to the diurnal inequality, which will be investigated further on.

*Effect of the Changes in the Moon's Declination and Parallax on the half-monthly Inequality, in Time.*—In reference to the investigation of the half-monthly inequality, it is comparatively of little consequence which transit of the moon is taken for comparison; it is otherwise in the investigation of the effect of a change in the moon's declination and parallax, as well as for a similar effect due to the sun, which latter, however, cannot become a subject of investigation for the tidal series in hand, on account of its short extent; for the same reason, the variation in the inequality, in height, will have to be passed over. To ascertain the effect due to the moon's declination and parallax, an anterior value, corresponding to a certain age of the tide, is to be taken in the comparison; the preceding investigation gave for the retard  $1\frac{1}{2}$  day, each lunital interval, minus its corresponding mean value for the respective hour of the moon's transit, was therefore tabulated in respect to the moon's declination and parallax (separately for each), corresponding to one day anterior to the time of high or low water, thus referring the results to transit *E*. The present investigation can only furnish an approximation to the true results; the

<sup>1</sup> For comparison of different values for this ratio, the following have been selected:  $\frac{S''}{M''}$  for London, 0.379; for Plymouth, 0.407; from the discussions of the Superintendent of the U. S. Coast Survey, for Key West, 0.325; San Diego, 0.39; and San Francisco, 0.342. (*Annual Reports of 1853 and '54.*)  $\frac{S'''}{M'''} for Dundee, 0.277; for Brest, 0.346; for Plymouth, 0.294.$

observations, while they give reliable value for the half-monthly inequality, cannot be expected to give more than an approximation to its variations. For any one station, and any one inequality or correction to it, special examinations require to be made to ascertain that transit of the moon, best suited for the purpose; this has hardly been done for any standard station, and it suffices to state here that, by referring to an anterior transit, the whole half-monthly inequality is moved backward through nearly twenty-four minutes for every transit preceding. Upon the inequality itself, the effect is but of a differential character. Thus to refer our table to transit *B*, deduct 24" from each value.

To concentrate as many values as possible to a mean, the changes of declination and parallax were grouped for three values. The separate parcels for declination are for declination 0 to 13°, 13° to 21°, and 21° to 27°.5, irrespective of sign. The parallax groups are: 54' to 56', 56' to 58', and 58' to 61'.4.

The differences of interval for the high and low waters were made out separately, and, in general, agreed tolerably well. I obtained the following results:—

TABLE SHOWING THE CORRECTION (IN MINUTES) TO THE MEAN HOURLY INTERVAL, FOR A CHANGE IN THE MOON'S DECLINATION AND PARALLAX.

| Moon's transit | Correction to interval for moon's declination. |                  |                  | Correction to interval for moon's parallax. |                   |                  |
|----------------|------------------------------------------------|------------------|------------------|---------------------------------------------|-------------------|------------------|
|                | 0 to 13°                                       | 13 to 21°        | 21 to 27°.5      | 54' to 56'                                  | 56' to 58'        | 58' to 61'.4     |
| 0h 30m         | — 2 <sup>m</sup>                               | — 7 <sup>m</sup> | + 5 <sup>m</sup> | — 12 <sup>m</sup>                           | + 14 <sup>m</sup> | — 7 <sup>m</sup> |
| 1 30           | + 15                                           | — 5              | + 18             | — 17                                        | + 17              | + 5              |
| 2 30           | + 21                                           | — 7              | + 12             | — 11                                        | + 12              | + 2              |
| 3 30           | + 23                                           | — 11             | — 9              | — 1                                         | + 20              | — 10             |
| 4 30           | + 9                                            | 0                | — 13             | — 1                                         | + 1               | — 3              |
| 5 30           | + 14                                           | + 4              | — 15             | + 14                                        | + 10              | — 36             |
| 6 30           | — 9                                            | + 18             | — 3              | + 7                                         | — 3               | — 2              |
| 7 30           | + 1                                            | — 13             | + 9              | + 5                                         | — 3               | — 4              |
| 8 30           | — 2                                            | + 9              | + 15             | + 26                                        | — 10              | + 8              |
| 9 30           | — 6                                            | + 1              | + 22             | + 9                                         | — 11              | — 5              |
| 10 30          | + 1                                            | — 6              | + 10             | + 10                                        | — 9               | — 7              |
| 11 30          | — 3                                            | — 2              | + 3              | — 4                                         | + 4               | + 4              |
| Mean           | + 5 <sup>m</sup>                               | — 1 <sup>m</sup> | — 1 <sup>m</sup> | + 2 <sup>m</sup>                            | + 4 <sup>m</sup>  | — 5 <sup>m</sup> |
| No. of observ. | 373                                            | 262              | 348              | 387                                         | 244               | 333              |

Mean declination 16°.0.

Mean parallax 57'.0.

The above table of declination corrections exhibits systematic values for the periodical part of the lunar effect, or for the term  $D \sin. 2 (\phi - \gamma)$ . Between 0° and 13° of declination, the correction is positive for transits between 1<sup>h</sup> and 7<sup>h</sup>, for other hours negative; for declinations between 13° and 21° it is positive, between the hours of 4 and 10; for remaining hours it is negative, and for declinations 21° to 27°.5, the correction is positive, for hours 7 to 1, and negative for remaining hours of transit. The quantity  $D$  is accordingly about 14 minutes, and  $\gamma$  equals 15°, 60°, and 105° respectively.

The variation in the inequality due to the changes of the moon's declination appears large when compared with its value at other places, but is in conformity with the large value of the half-monthly inequality itself.

The periodical part of the parallax correction is of the same form as given above.



The empirical values for the groups of small and middle values of parallax appear systematic; the values in the last column for large parallax are less regular. The maximum correction on the average is somewhat greater than one-fourth of an hour.

The corrections to the mean establishment for changes of the sun's declination and parallax may be taken as one-third of the corresponding lunar values, and in the present case will probably not exceed five minutes of time.

The means of each column, containing the non-periodical part, are small, and appear rather irregular; they are variable with the transit or the moon's age adopted in the discussion.<sup>1</sup>

*Diurnal Inequality.*—We now proceed to the examination of a prominent feature in the Rensselaer Harbor tides, namely, the diurnal inequality. This inequality is well marked in the diagrams, Plates I, II, and III. Although the existence of this inequality, in height and times, has long been known to practical men, it was not until about twenty-five years ago that its laws were understood and reduced to computation by Mr. Whewell.<sup>2</sup> The subject has since been taken up by the present superintendent of the U. S. Coast Survey, Prof. Bache;<sup>3</sup> his researches commenced about nine years ago, and resulted in a further extension of the method of discussion as well as in the recognition of the geographical limits of the phenomena on our own coast; further, the discussion of single day tides, produced by this inequality in extreme cases, and here complicated by an extremely small rise and fall of the tides, was now successfully accomplished. According to the equilibrium theory, the diurnal tide ought to be very small in latitude 79°; but viewing the Rensselaer Harbor tide as a wave, produced principally in the Atlantic, and propagated through Davis's and Smith's Straits, the existence of the diurnal inequality in so high a northern latitude cannot surprise us. The following notes were extracted from Captain McIntock's narrative of the voyage of the "Fox,"

<sup>1</sup> On this point the reader may consult Whewell's 9th series of tidal researches: "Laws of the Tides from a Short Series of Observations," *Phil. Trans.* 1838; also Airy, "Tides and Waves," articles 552 and following.

<sup>2</sup> Researches on the Tides, sixth series. On the Results of an Extensive System of Tide Observations made on the Coasts of Europe and America in June, 1835. By the Rev. W. Whewell. *Phil. Trans. Roy. Soc.* 1836.

Researches on the Tides, seventh series. On the Diurnal Inequality of the Height of the Tide, especially at Plymouth and Singapore. By the same author. *Phil. Trans.* 1837.

Researches on the Tides, eighth series. On the Progress of the Diurnal Inequality Wave along the Coasts of Europe. By the same author. *Phil. Trans. Roy. Soc.* 1837.

<sup>3</sup> Note on a Discussion of Tidal Observations at Cat Island in the Gulf of Mexico, by Prof. A. D. Bache. *Coast Survey Report for 1851, App. No. 7*; Additional Notes thereto, *Coast Survey Report for 1852, App. No. 22*.

On the Tides at Key West and of the Western Coast of the United States. *Coast Survey Report for 1853, App. Nos. 27 and 28*. By Prof. A. D. Bache.

Comparison of the Diurnal Inequality of the Tides at San Diego, San Francisco, and Astoria, on the Pacific Coast of the United States. *Coast Survey Report for 1854, App. No. 26*. By Prof. A. D. Bache.

Approximate Co-Tidal Lines of Diurnal and Semi-Diurnal Tides of the Coast of the United States on the Gulf of Mexico. *Coast Survey Report for 1856, App. No. 35*. By Prof. A. D. Bache.

For the theoretical investigation of the diurnal tide, see also Airy's *Tides and Waves*, articles 46 and following; and articles 562 and following.

in 1857, '58, '59. Referring to Bellet Strait: "As in Greenland, the night tides are much higher than the day tides." Speaking of the ice motion, and remarking that the tides are the chief cause of it, he says: "Now we know that the night tides in Greenland greatly exceed the day tides." Also, when near Buchan Island, north of Upernavik, and in the vicinity of Cape Shackleton: "We had grounded during the day tide, and were floated off by the night tide, which on this coast occasions a much greater rise and fall." By the labors of Dr. Kane we now know that the diurnal inequality extends as high up as  $79^{\circ}$  of latitude on the north-western coast of Upper Greenland. In a report of Mr. Sonntag's to Dr. Kane, dated Godhavn, Sept. 12, 1855, he says: The mean height of spring tides is 12.8 feet, and at the time of new and full moon high water is at  $12^h 0^m$ ; the highest spring tide is three days after full moon, and the night tide is at this time fully three feet higher than the day tide. At Northumberland Island, Sept. 10, 1854, at (after) the time of full moon high water was at  $11^h$  P. M., and the night tide rose three feet more than the day tide. These statements, crude as they necessarily are, show that the attention of the party was fully directed to the phenomenon.

A cursory examination of the Plates (I, II, and III) shows that the diurnal inequality extends without exception over the whole series of observation, that it is well marked in the difference of the height of high water, but very little or irregularly in the height of low water; that sometimes the day tide, at other times the night tide is the higher of the two occurring in a lunar day; further, that it vanishes a day or two after the moon's crossing the equator, and that it amounts in *maximo* to about three feet some time after the moon attains her greatest declination. There is but one instance where the inequality approximates to the production of a single day tide. See curve for Nov. 23, 1853.

We may now enter somewhat more fully into the discussion of this inequality, which is produced by the interference of two independent waves, the diurnal and the semi-diurnal, the former depending for its size chiefly on the moon's declination. For a complete study of these compound waves, they require to be examined in their separate parts, and it would therefore be our first object to effect their separation into the diurnal and the semi-diurnal; a process which, when graphically performed, is neither too laborious nor lacking in accuracy; it is nevertheless a process of some nicety, and requires observations of standard excellence. Upon trial, I found the less rigorous method employed by Mr. Whewell in his discussion of the Plymouth and Singapore tides, was better suited to the general mass of the observations at Van Rensselaer, and that the above described process of separation had better be reserved to that portion of our observations which are apparently of the best character.

The observed heights of high and low water were laid down graphically, and a line was drawn by the eye, cutting off the zigzags of the successive high waters, leaving equal portions above and below the intermediate curve. These differences from the mean height were then set off from another axis, and those belonging to the high water next following the moon's superior transit were marked by a curve of dashes; those following the moon's inferior transit were marked by a curve of dots. These curves, without exception, were found to have alternately, as the

[illegible]

The mean declination corresponds to an epoch 1.6 days anterior, which remark applies also to the formula  $dh = C \sin 2\delta$ , representing the diurnal inequality  $dh$  in two successive high or low waters,  $\delta$  being the moon's declination. For the value of  $C$  we obtain 3.3, which gives us the following comparison:—

DIURNAL INEQUALITY IN HEIGHT.  
(Epoch 1.6 days.)

| Moon's declination. | Observed $dh$ . | Computed $dh$ . | Difference. |
|---------------------|-----------------|-----------------|-------------|
|                     | Feet.           | Feet.           | Feet.       |
| 0°                  | 0.0             | 0.0             | 0.0         |
| 12                  | 1.4             | 1.4             | 0.0         |
| 21                  | 2.3             | 2.2             | 0.1         |
| 25                  | 2.5             | 2.5             | 0.0         |
| 22                  | 2.3             | 2.3             | 0.0         |
| 13                  | 1.7             | 1.5             | 0.2         |
| 0                   | 0.0             | 0.0             | 0.0         |

The diurnal inequality in time I have tried to exhibit by numbers as well as by diagrams; it seems, however, that the incidental irregularities in the observations themselves, coupled with the fact that the observations generally were only made half-hourly and at other times hourly—so far exceed in magnitude the inequality itself as to make the effect of the changes of the moon's declination exceedingly obscure. The lunital intervals (for high and low water) between Oct. 17 and Dec. 28, 1853, between Jan. 28 and March 7, 1854, and between June 1 and July 7, 1854, were tabulated in vertical columns; the means of the alternate values were tabulated in the 2d column, and placed in the horizontal line opposite the intermediate value of column one. The numbers in the first column were next subtracted from the corresponding numbers in the second column, if the interval belonged to the inferior transit; if belonging to the superior, the values in the second column were subtracted from those in the first. The moon's declination, for noon each day, was also set down. The 276 values for diurnal inequality in time, thus obtained, were plotted. After attempting to deduce an epoch and arranging the values for different assumptions for epoch, no satisfactory result could be obtained in any way according with the expression

$$d\psi = \frac{g \tan \delta}{1 + A \cos \phi} \quad (\text{see Lubbock, Phil. Trans. 1837}),$$

and the results of the investigation must be confined to the following general remark. The diurnal inequality in time is in maxima probably not exceeding two hours; it seems to be less in amount for the times of high water than for the times of low water, a result the reverse of that belonging to the inequality in height. A similar conclusion was arrived at in the discussion of the tides at San Francisco, Cal. (Prof. A. D. Bache in Coast Survey Report for 1853, p. 81), when the *smaller* inequality in height of high water (when compared with that for low water) corresponded to the *greater* inequality in time of high water (when compared with the inequality for low water). Whether the inequality of the height for high or low water is the greater or smaller depends only on the epoch of the diurnal wave compared with the epoch of the semi-diurnal wave. There is no regular increase

of the inequality corresponding to an increasing (irrespective of sign) declination of the moon, but the curve appears double-crested about the time of maximum declination, there being a sudden diminution in the inequality, preceded and followed by high values; about the time of the moon's crossing the equator the inequality is very irregular.

On Plate IV, the actual separation of the semi-diurnal and the diurnal wave has been effected graphically, for which purpose a part of the best observations was selected; these observations extend over the period from Oct. 30 to Nov. 22, 1853. The process of decomposition in use in the U. S. Coast Survey was at first an analytical one, by computing sine curves; since 1855, however, a graphical process, equivalent thereto, was substituted; this latter method, as introduced by assistant L. F. Pourtales, may be briefly explained as follows: After the observations are plotted and a tracing is taken, the traced curves are shifted in epoch 12 (lunar) hours forward, when a mean curve is pricked off between the observed and traced curves; this process is repeated after the tracing paper has been shifted 12 hours backward; the average or mean pricked curve thus obtained represents the semi-diurnal wave. On an axis parallel with that on which the time is counted, the differences between the originally observed and the constructed semi-diurnal wave were laid off; this constitutes the diurnal curve. In the case in hand I have simplified the process of separation by blackening the under surface of the tracing paper with a lead pencil, and running in with a free hand; the intermediate curves by the pressure of a style, an average of the two traces thus left on the lower paper, gave the semi-diurnal wave in quite an expeditious manner. On the diagram, the diurnal curve with its epoch of high water nearly coinciding with that of the semi-diurnal wave, appears plainly with its variation in size depending on the moon's declination.

*Investigation of the Form of the Tide Wave.*—The shape of the tide wave has been ascertained in the manner described in art. (479) Tides and Waves, and depends on the hourly observations of 60 tides, 30 during spring tides and an equal number during neap tides, that is, the observed heights on the day of the syzygies and quadratures and on the first and second day after, were tabulated, forming ten groups of three columns each, from low water to low water. The columns of an equal number of hours (they vary from 16 hours to 11 hours) were united in a mean. In order to combine these it was assumed that the interval from the observed low water to the next following low water corresponds to  $360^\circ$  of phase, and the time of every intermediate observation was converted into phase by that proportion. In order to render the observed heights comparable, the range from high to low water in every half tide (the reading of low water for phase 0 generally not being identical with the reading of the succeeding low water or phase  $360^\circ$ ) was supposed to correspond to 2.00, and the elevation above the low water was converted into number by that proportion, thus furnishing a series of ordinates for equidistant abscissæ. The means of all the phases and corresponding converted depressions within every 30th degree of phase were then taken with proper regard to the weights, depending on the number of columns, of equal hours, united at the commencement of the reduction. By observation of the progress of the numbers,

it was easy to alter the latter so as to make them exactly correspond to the phases 30°, 60°, 90°, 120°, etc. In this manner the following numbers have been obtained:—

FOR THE SPRING-TIDE WAVE OCCURRING ONE AND A QUARTER DAY AFTER FULL AND NEW MOON.

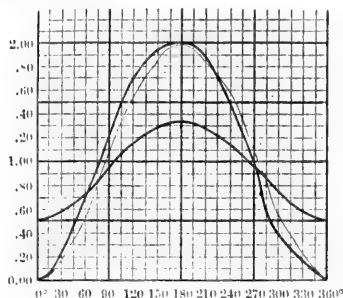
| Phase of groups. |     |     |     |     |       | Proportional height above low water. |      |      |      |      |       |
|------------------|-----|-----|-----|-----|-------|--------------------------------------|------|------|------|------|-------|
| 0°               | 0°  | 0°  | 0°  | 0°  | Mean. | 0.00                                 | 0.00 | 0.00 | 0.00 | 0.00 | Mean. |
| 26               | 28  | 30  | 33  | 36  | 30    | 0.06                                 | 0.23 | 0.24 | 0.27 | 0.10 | 0.21  |
| 51               | 55  | 60  | 65  | 72  | 59    | 0.32                                 | 0.68 | 0.90 | 0.70 | 0.46 | 0.71  |
| 77               | 83  | 90  | 98  | 108 | 89    | 0.91                                 | 1.13 | 1.36 | 1.32 | 1.17 | 1.24  |
| 103              | 111 | 120 | 131 | 144 | 120   | 1.39                                 | 1.68 | 1.73 | 1.76 | 1.52 | 1.70  |
| 129              | 138 | 150 | 164 | 180 | 156   | 1.84                                 | 2.04 | 1.98 | 1.93 | 2.00 | 1.95  |
| 154              | 166 | 180 | 196 | 216 | 180   | 1.94                                 | 1.98 | 2.00 | 2.00 | 1.88 | 2.00  |
| 180              | 194 | 210 | 229 | 252 | 208   | 2.00                                 | 2.00 | 1.84 | 1.56 | 1.23 | 1.88  |
| 206              | 222 | 240 | 262 | 288 | 237   | 1.84                                 | 1.74 | 1.45 | 1.15 | 0.70 | 1.46  |
| 231              | 249 | 270 | 294 | 324 | 270   | 1.58                                 | 1.23 | 1.00 | 0.65 | 0.41 | 0.97  |
| 257              | 277 | 300 | 327 | 360 | 300   | 1.14                                 | 0.79 | 0.27 | 0.25 | 0.00 | 0.37  |
| 283              | 305 | 330 | 360 | 360 | 330   | 0.60                                 | 0.40 | 0.17 | 0.00 |      | 0.17  |
| 309              | 332 | 360 |     |     | 360   | 0.15                                 | 0.16 | 0.00 |      |      | 0.00  |
| 334              | 360 |     |     |     |       | 0.02                                 | 0.00 |      |      |      |       |
| 360              |     |     |     |     |       | 0.00                                 |      |      |      |      |       |
| Weight           | 5   | 4   | 13  | 7   | 1     | Weight                               | 5    | 4    | 13   | 7    | 1     |

The columns headed "mean" show the ordinates of the waves for (nearly) equidistant intervals of time.

The following table contains the corresponding numbers for the neap tide wave occurring 14 day after the first and last quarter, and as derived from 30 tides observed hourly from low to low water:—

| Phase of groups. |     |     |     |     |       | Proportional height above low water. |      |      |      |      |       |
|------------------|-----|-----|-----|-----|-------|--------------------------------------|------|------|------|------|-------|
| 0                | 0   | 0   | 0   | 0   | Mean. | 0.00                                 | 0.00 | 0.00 | 0.00 | 0.00 | Mean. |
| 24               | 26  | 28  | 30  | 33  | 29    | 0.07                                 | 0.00 |      |      |      |       |
| 48               | 51  | 55  | 60  | 65  | 58    | 0.26                                 | 0.17 | 0.00 |      |      |       |
| 72               | 77  | 83  | 90  | 98  | 89    | 0.49                                 | 0.55 | 0.24 | 0.00 |      |       |
| 96               | 103 | 111 | 120 | 131 | 119   | 0.89                                 | 1.11 | 0.59 | 0.20 | 0.00 |       |
| 120              | 129 | 138 | 150 | 164 | 147   | 1.19                                 | 1.53 | 0.93 | 0.50 | 0.00 | 0.52  |
| 144              | 154 | 166 | 180 | 196 | 180   | 1.55                                 | 1.83 | 1.35 | 1.05 | 1.02 | 1.08  |
| 168              | 180 | 194 | 210 | 229 | 208   | 0.82                                 | 2.00 | 1.73 | 1.60 | 1.44 | 0.35  |
| 192              | 206 | 222 | 240 | 262 | 237   | 2.00                                 | 1.95 | 2.00 | 1.85 | 1.81 | 1.06  |
| 216              | 231 | 249 | 270 | 294 | 270   | 1.92                                 | 1.62 | 1.36 | 2.00 | 2.00 | 1.88  |
| 240              | 257 | 277 | 300 | 327 | 300   | 1.64                                 | 1.43 | 1.72 | 2.00 | 1.72 | 2.00  |
| 264              | 283 | 305 | 330 | 360 | 330   | 1.25                                 | 1.00 | 1.32 | 1.84 | 1.43 | 1.63  |
| 288              | 309 | 332 | 360 |     | 360   | 0.94                                 | 0.67 | 0.80 | 1.37 | 0.79 | 0.99  |
| 312              | 334 | 360 |     |     | 360   | 0.51                                 | 0.24 | 0.32 | 0.79 | 0.15 | 0.10  |
| 336              | 360 |     |     |     | 360   | 0.23                                 | 0.05 | 0.04 | 0.42 | 0.00 | 0.00  |
| 360              |     |     |     |     | 360   | 0.00                                 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00  |
| Weight           | 3   | 4   | 8   | 13  | 1     | Weight                               | 3    | 4    | 8    | 13   | 1     |

The results are represented in the annexed diagram. The result for the neap tide curve has also been multiplied by  $\frac{1}{11.1}$ , the ratio of neap and spring tide range as found on a preceding page, and was increased by 0.5 to refer it to the same level.



The full curves in the diagram show the form of the spring and neap tide wave (the scales being arbitrary), to which has been added for convenient comparison the dotted curve representing the neap tide wave on the same relative scale as the spring tide wave. It is apparent that the spring tide wave is slightly steeper between low and high water than between high and low water, and that the neap tide wave is very nearly symmetrical in respect to rise and fall.

We have seen that the duration of rise is  $6^h 04^m.7$ , hence the duration of fall will be  $6^h 19^m.7$ ; or in making ebb the time is 15 minutes greater than in making flood, a circumstance in conformity with the shape of the curves of rise and fall. This holds good for an average tide; according to art. (510) 'Tides and Waves, if the place of observation is not far from the sea, or, as in our case, in a bay, the water will occupy a shorter time to rise than to fall, and the inequality will be greater at spring tides than at neap tides; this is fully illustrated in the preceding diagram, the spring tide wave being the steeper of the two.

The form of the tide waves will be found closely represented by the following expressions:—

For the spring tide wave—

$$5.83 + 5.58 \sin. (\theta + 278^\circ) + 0.20 \sin. (2\theta + 281^\circ);$$

For the neap tide wave—

$$2.42 + 2.25 \sin. (\theta + 269^\circ) + 0.09 \sin. (2\theta + 290^\circ);$$

in which expressions the angle  $\theta$  counts from low water to low water, from 0 to  $360^\circ$ , and the height of the wave is expressed in feet.

The relative numbers, given above as the ordinates, have been changed in the proportion of 2 to 11.1 for the higher and of 2 to 4.7 for the lower wave. The following table shows the agreement between observation and the numerical expressions, in which the 3d and higher terms are zero:—

FORM OF THE TIDE WAVE AT VAN RENSSELAER HARBOR.

| Phase. | Height of Spring tide, in feet. |           | Height of neap tide, in feet. |           |
|--------|---------------------------------|-----------|-------------------------------|-----------|
|        | Observed.                       | Computed. | Observed.                     | Computed. |
| 0      | 0.0                             | 0.1       | 0.0                           | 0.1       |
| 30     | 1.2                             | 1.4       | 0.5                           | 0.4       |
| 60     | 3.9                             | 3.9       | 1.3                           | 1.3       |
| 90     | 6.9                             | 6.8       | 2.5                           | 2.5       |
| 120    | 9.4                             | 9.3       | 3.5                           | 3.5       |
| 150    | 10.7                            | 10.9      | 4.3                           | 4.3       |
| 180    | 11.1                            | 11.1      | 4.6                           | 4.6       |
| 210    | 10.4                            | 10.2      | 4.3                           | 4.4       |
| 240    | 7.9                             | 8.0       | 3.7                           | 3.7       |
| 270    | 5.4                             | 5.3       | 2.5                           | 2.5       |
| 300    | 2.1                             | 2.4       | 1.3                           | 1.3       |
| 330    | 0.9                             | 0.5       | 0.5                           | 0.4       |
| 360    | 0.0                             | 0.1       | 0.0                           | 0.1       |

Respecting the effect of the wind and ice on the tides, it may be remarked that the former can only be slight, since the sea is protected from the direct action of the wind by its icy cover for the greater part of the year. When the sea is partially open, the effect becomes sensible, as may be seen by the following note extracted from the log-book:—

"August 17, 1853. The above records show a heavy gale from the southward gradually hauling to the eastward; the effect of this gale on the tides was very marked; our flood rose two feet above any previous register, overflowing the ground ice, and our last ebb or outgoing tide was hardly perceptible." The ice crust cannot sensibly affect (by friction on its lower surface) the progress of the tide wave, and will certainly not sensibly interfere (by friction on the ice foot and breakage of the ice fields) with the rise and fall of the tide.

*Progress of the Tide Wave.*—The tide at Van Rensselaer Harbor may be taken as a derived tide, and transmitted to it from the Atlantic Ocean, and in part modified by the small tide originating in the waters of Baffin's Bay; which latter tide, however, must necessarily be small, particularly on account of the general direction of the bay, which is very unfavorable for the production of a tide wave. That the tide wave is travelling up along the western coast of Greenland, or, in other words, reaches Van Rensselaer Harbor from the southward, may be seen from the following observed establishments:—

*Holsteinborg Harbor*, latitude  $66^{\circ} 56'$ , longitude  $53^{\circ} 42'$ . High water at F. & C.  $6^h 30^m$ . Spring tides rise 10 feet.—Capt. Inglefield, 1853.

*Whalefish Islands* (near Disco), latitude  $68^{\circ} 59'$ , longitude  $53^{\circ} 13'$ . Time of high water F. & C.  $8^h 15^m$ . Highest tide  $7\frac{1}{2}$  feet.—Parry's 3d Voyage of Discovery.

*Godhavn* (Disco), latitude  $69^{\circ} 12'$ , longitude  $53^{\circ} 28'$ . Tidal hour  $9^h$ . Rise and fall  $7\frac{1}{2}$  feet.—See Map in Narrative of Kane's First Voyage.

*Upernavik*, latitude  $72^{\circ} 47'$ , longitude  $56^{\circ} 03'$ . High water at F. & C.  $11^h$ . Rise 8 feet.—Capt. Inglefield, 1854.

*Wolstenholm Sound*, latitude  $76^{\circ} 33'$ , longitude  $68^{\circ} 56'$ . High water at F. & C.  $11^h 8^m$ . Rise, both at spring and neaps, 7 to  $7\frac{1}{2}$  feet.—(See Admiralty Chart of Baffin's Bay, sheet 1, 1853, corrected to 1859.) The observations themselves, taken by Captain Saunders of H. M. S. *North Star*, in 1849 and 1850, were kindly fur-



nished to Prof. Bache by the Hydrographer to the Admiralty, Captain J. Washington, R. N., and are given in the appendix to this paper. And finally,

*Van Rensselaer Harbor*, latitude  $78^{\circ} 37'$ , longitude  $70^{\circ} 53'$ . High water at F. & C.  $11^h 50^m$ , as derived from the preceding analytical expression. Rise and fall at spring tide 11.1 feet, at neap tide 4.7 feet, average range 7.9 feet.

By means of the difference in the establishments of Holsteinborg and Van Rensselaer, we can obtain an approximation to the depth of Baffin's Bay and Smith's Straits, viz:—

|                | Total hour | Longitude  | Sum         | Difference |                                                         |
|----------------|------------|------------|-------------|------------|---------------------------------------------------------|
| Holsteinborg   | $6^h 30^m$ | $3^h 35^m$ | $10^h 05^m$ |            |                                                         |
| Van Rensselaer | 11 50      | 4 43       | 16 33       | $6^h 28^m$ | { Difference corrected for the moon's motion $6^h 26^m$ |

Assuming the distance along the channel to be 770 nautical miles, we have a velocity of the tide wave of about 202 feet in a second, which, according to Airy's table (174), Tides and Waves, would correspond to a depth of nearly 1300 feet, or about 220 fathoms—a result probably smaller than the true value, since the other observations indicate a greater depth, it may be taken as an inferior limit; in the same manner we find from the eotidal hours of Upernavik and Van Rensselaer a depth of near 800 fathoms, and a similar result from the Wolstenholm observations; this last result may perhaps be taken as an upper limit.

*Soundings.*—The following soundings have been copied from the log-book:—

|                  |                                                                                                          |
|------------------|----------------------------------------------------------------------------------------------------------|
| June 19, 1853.   | Lat. $51^{\circ} 12'$ , long. $52^{\circ} 8'$ (government sounding twine and 32-pound shot)              |
| Chronometer time | Mark                                                                                                     |
| 8 47 0           | Red started                                                                                              |
| 10 10            | White                                                                                                    |
| 2 10             | Bottom, with 178 fathoms; shot brought up with gray mud and fine sand. The line was afterwards measured. |

|                                   |                                        |                                                                                              |                                     |
|-----------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------|-------------------------------------|
| June 26, 1853.                    |                                        | Lat. $59^{\circ} 48'$ , long. $50^{\circ} 3'$ (government sounding twine and 32-pound shot). |                                     |
| Chronometer time.                 | Mark.                                  | Chronometer time.                                                                            | Mark.                               |
| 3 56 <sup>m</sup> 35 <sup>s</sup> | Started 75 fathoms from the next mark. | 4 <sup>h</sup> 21 <sup>m</sup> 25 <sup>s</sup>                                               | White                               |
| 57 25                             | Red.                                   | 25 10                                                                                        | Red.                                |
| 58 50                             | White                                  | 29 15                                                                                        | White.                              |
| 1 00 37                           | Red                                    | 33 25                                                                                        | Red.                                |
| 2 18                              | Black                                  | 37 30                                                                                        | Black.                              |
| 5 16                              | White.                                 | 42 0                                                                                         | White                               |
| 8 0                               | Red.                                   | 46 30                                                                                        | Red.                                |
| 11 0                              | White.                                 | 51 15                                                                                        | White                               |
| 14 5                              | Red.                                   | 56 0                                                                                         | Red.                                |
| .....                             | Missed the mark                        | 58 0                                                                                         | Bottom with 1817 fathoms, line cut. |

August 1, 1858. Melville Bay, lat.  $75^{\circ} 40'$ , long.  $62^{\circ} 12'$  (government sounding twine and 32-pound shot)

| Chronometer time                              | Mark.                                                                               |
|-----------------------------------------------|-------------------------------------------------------------------------------------|
| 5 <sup>h</sup> 47 <sup>m</sup> 6 <sup>s</sup> | Started.                                                                            |
| 18 8                                          | Red.                                                                                |
| 19 40                                         | White.                                                                              |
| 51 40                                         | Red.                                                                                |
| 54 0                                          | Black.                                                                              |
| 54 45                                         | Bottom with 429 fathoms; shot brought up with dark green sand (specimen preserved). |

# APPENDIX.

TIDAL OBSERVATIONS MADE ON BOARD H. M. S. NORTH STAR, COMMANDER SAUNDERS, AT THE WINTER QUARTERS IN WOLSTENHOLM SOUND. (FROM THE SHIP'S LOG.)

| DATE.          | High water. |         | Low water. |         | DATE.          | High water. |         | Low water. |         |
|----------------|-------------|---------|------------|---------|----------------|-------------|---------|------------|---------|
|                | Time.       | Height. | Time.      | Height. |                | Time.       | Height. | Time.      | Height. |
| 1849.          |             |         |            |         | 1850.          |             |         |            |         |
| Nov. 16, A. M. | 12 0 0      | 78 0    | 4 0 0      | 69 4    | Mar. 13, P. M. |             | Ft. In. |            | Ft. In. |
| " 17, A. M.    |             |         | 5 30       | 70 11   | " 19, A. M.    | 3 0 0       | 75 0    | 6 0 0      | 69 0    |
| " 17, P. M.    | 0 30        | 78 6    |            |         | " 19, P. M.    |             |         | 11 0       | 70 10   |
| " 20, A. M.    | 11 0        | 76 5    | 5 0        | 71 4    | " 27, P. M.    | 11 0        | 76 2    | 5 30       | 67 9    |
| " 20, A. M.    | 10 0        | 79 1    | 4 30       | 70 0    | April 4, A. M. |             |         | 12 0       | 69 9    |
| Dec. 14, P. M. | 11 0        | 69 6    | 6 0        | 65 2    | " 4, P. M.     | 4 0         | 72 2    |            |         |
| " 22, P. M.    | 4 0         | 70 9    | 10 30      | 65 4    | " 12, A. M.    | 11 30       | 70 1    | 5 0        | 69 2    |
| " 29, A. M.    | 11 0        | 73 10   | 3 30       | 64 0    | " 26, A. M.    | 11 0        | 70 3    | 5 0        | 69 2    |
| 1850           |             |         |            |         | May 4, P. M.   | 5 0         | 75 0    |            |         |
| Jan. 13, A. M. | 12 0        | 71 6    | 5 30       | 64 2    | " 19, A. M.    | 5 30        | 77 2    |            |         |
| " 24, P. M.    | 4 0         | 70 4    | 10 30      | 65 1    | " 19, P. M.    |             |         | 11 20      | 72 6    |
| " 27, A. M.    | 11 0        | 72 4    | 5 30       | 64 2    | " 26, A. M.    | 1 0         | 75 10   | 6 0        | 69 0    |
| Feb. 3, P. M.  | 3 30        | 70 0    | 9 0        | 63 10   | June 2, P. M.  | 1 0         | 68 11   |            |         |
| " 19, P. M.    | 4 0         | 70 3    | 9 30       | 66 8    | " 23, P. M.    | 11 0        | 74 4    |            |         |
| March 5, P. M. | 4 30        | 70 0    | 10 0       | 66 10   | July 9, P. M.  | 11 0        | 74 10   | 3 0        | 66 1    |
| " 15, A. M.    | 11 30       | 75 0    |            |         |                |             |         |            |         |

From the rough manner with which the above observations appear to have been made, an approximate establishment and rise of tide only can be deduced from them.

H. W. F. and C. appears to take place between XI<sup>h</sup> 0<sup>m</sup> and XI<sup>h</sup> 15<sup>m</sup>, say XI<sup>h</sup> 8<sup>m</sup>, and the rise both at springs and neaps from 7 to 7½ feet

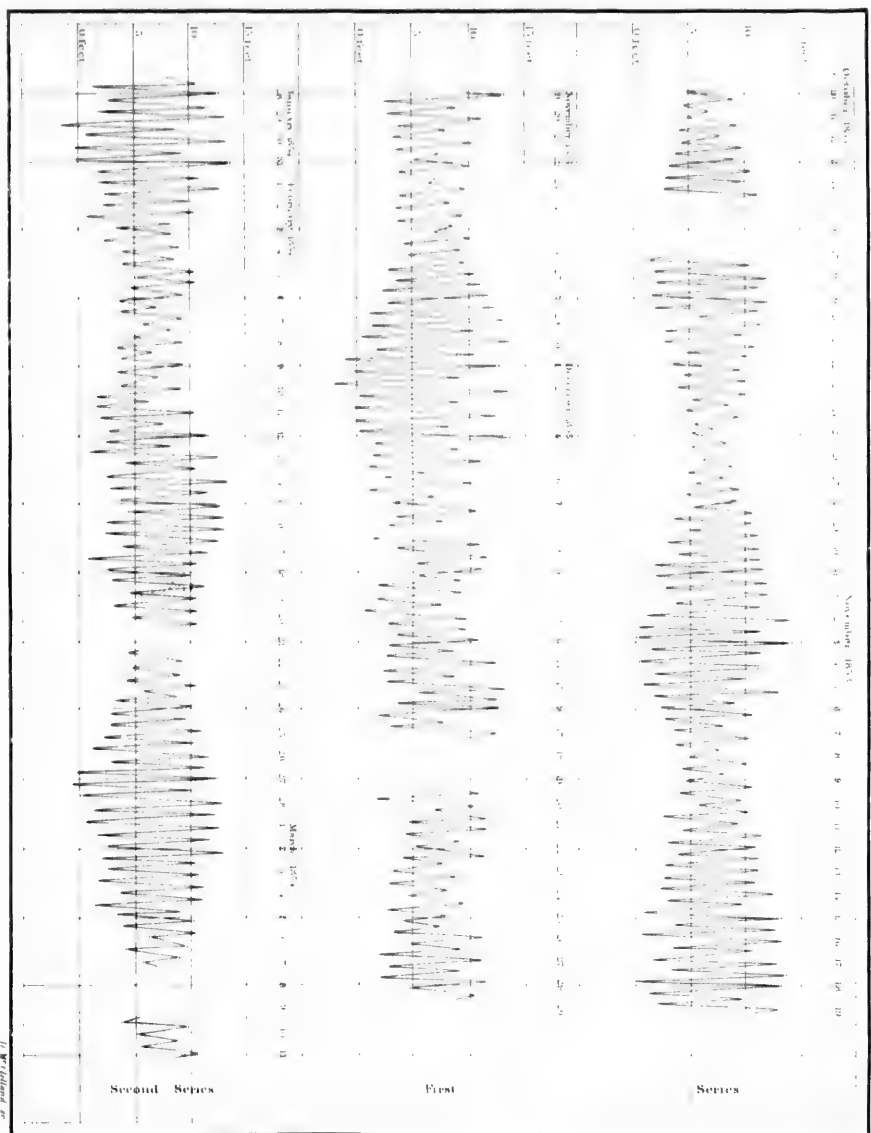
(Signed)

JNO. BURWOOD, MASTER R. N.,

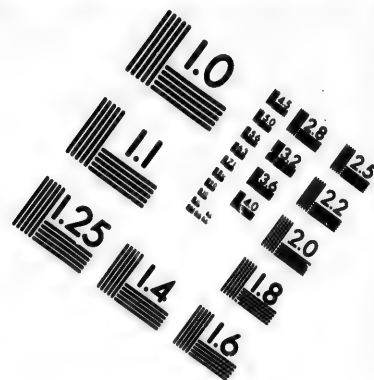
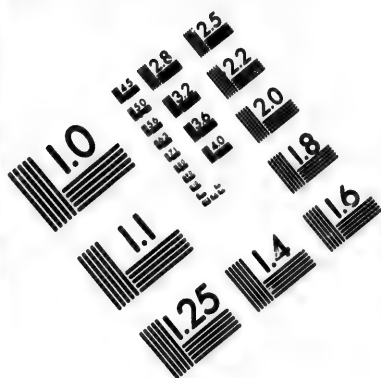
(Tide Computer).

ADMIRALTY, 3d July, 1860

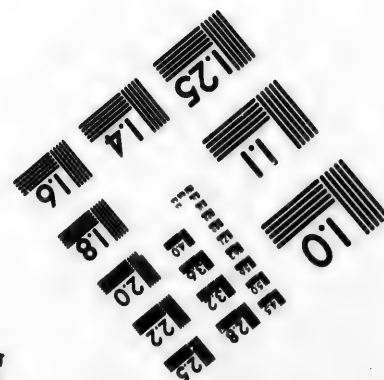
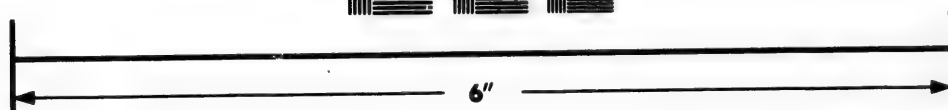
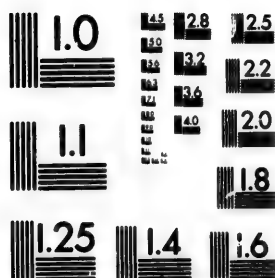
PUBLISHED BY THE SMITHSONIAN INSTITUTION,  
WASHINGTON CITY,  
OCTOBER, 1860.







# IMAGE EVALUATION TEST TARGET (MT-3)

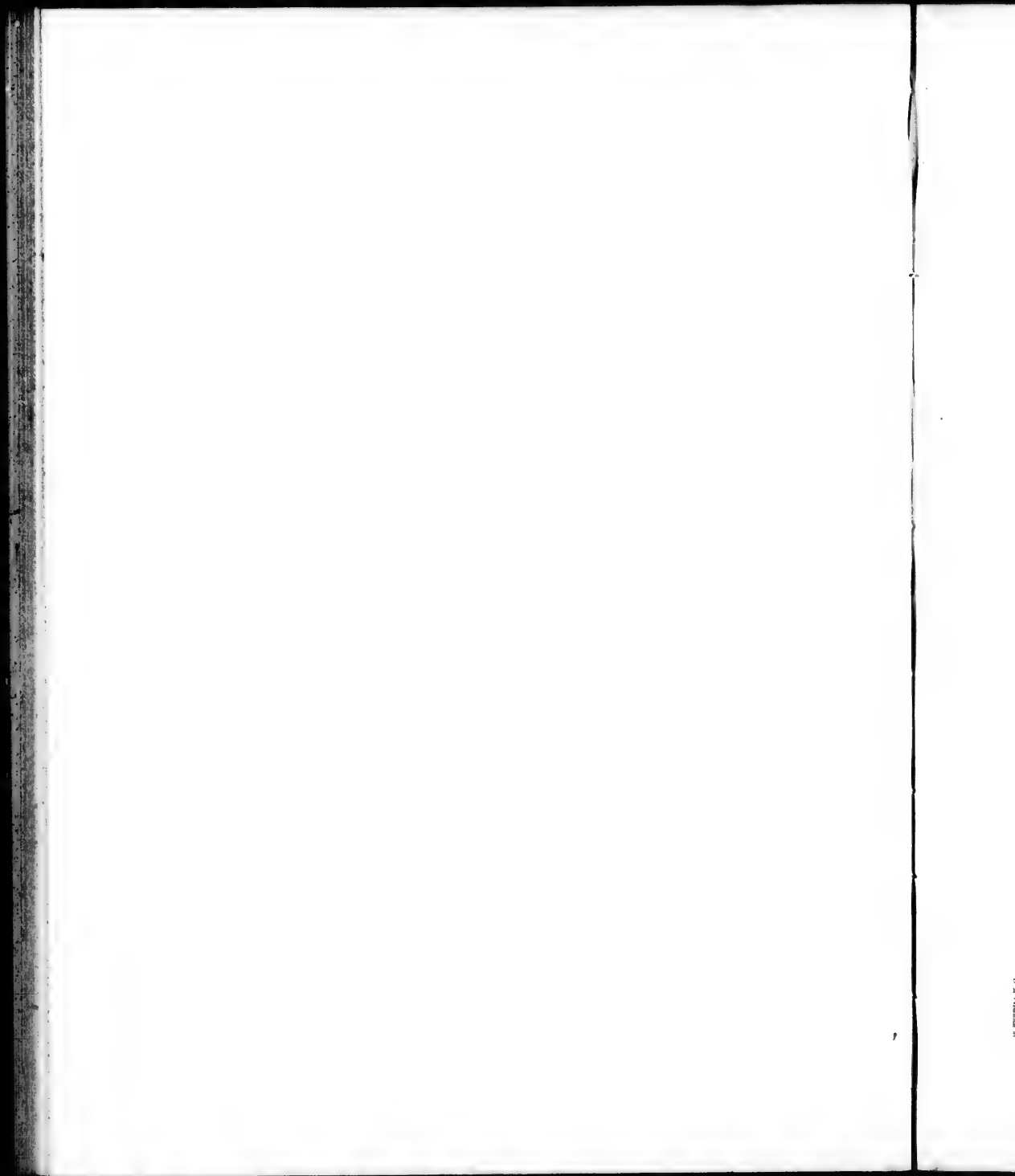


Photographic  
Sciences  
Corporation

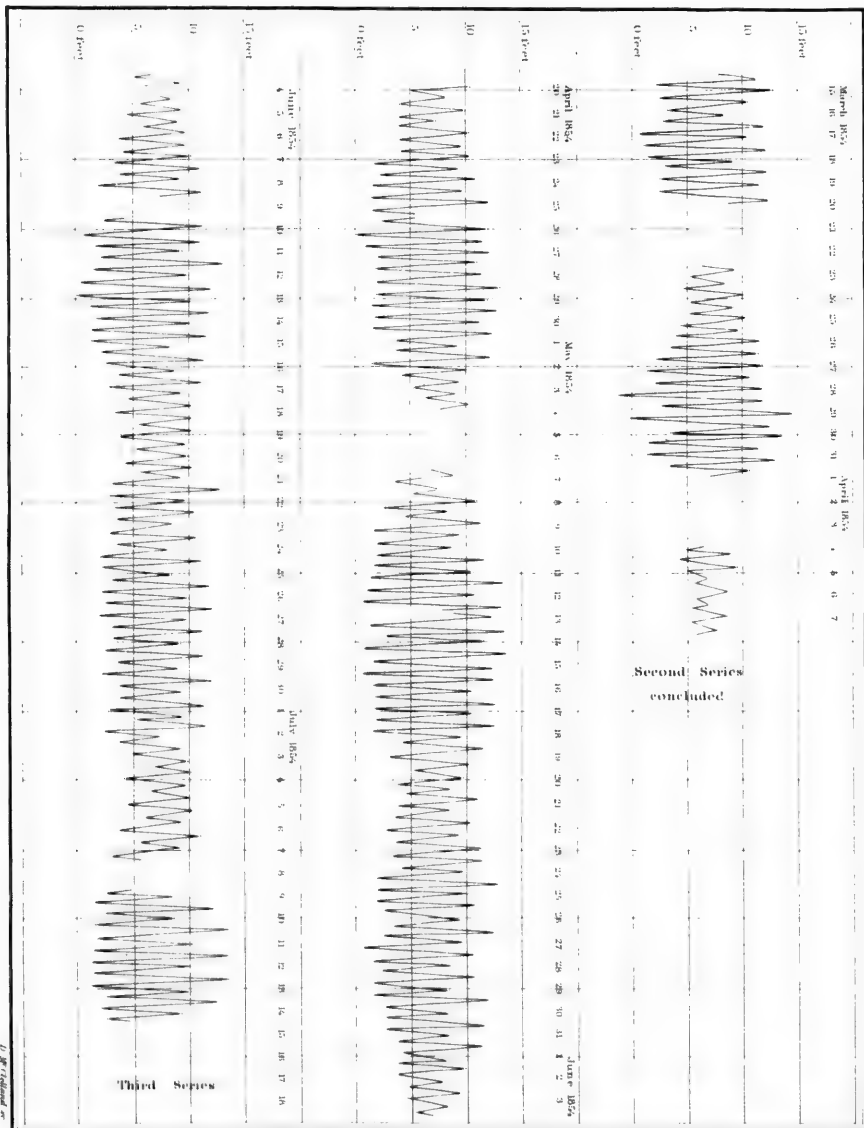
23 WEST MAIN STREET  
WEBSTER, N.Y. 14580  
(716) 872-4503

28  
25  
22  
20  
18

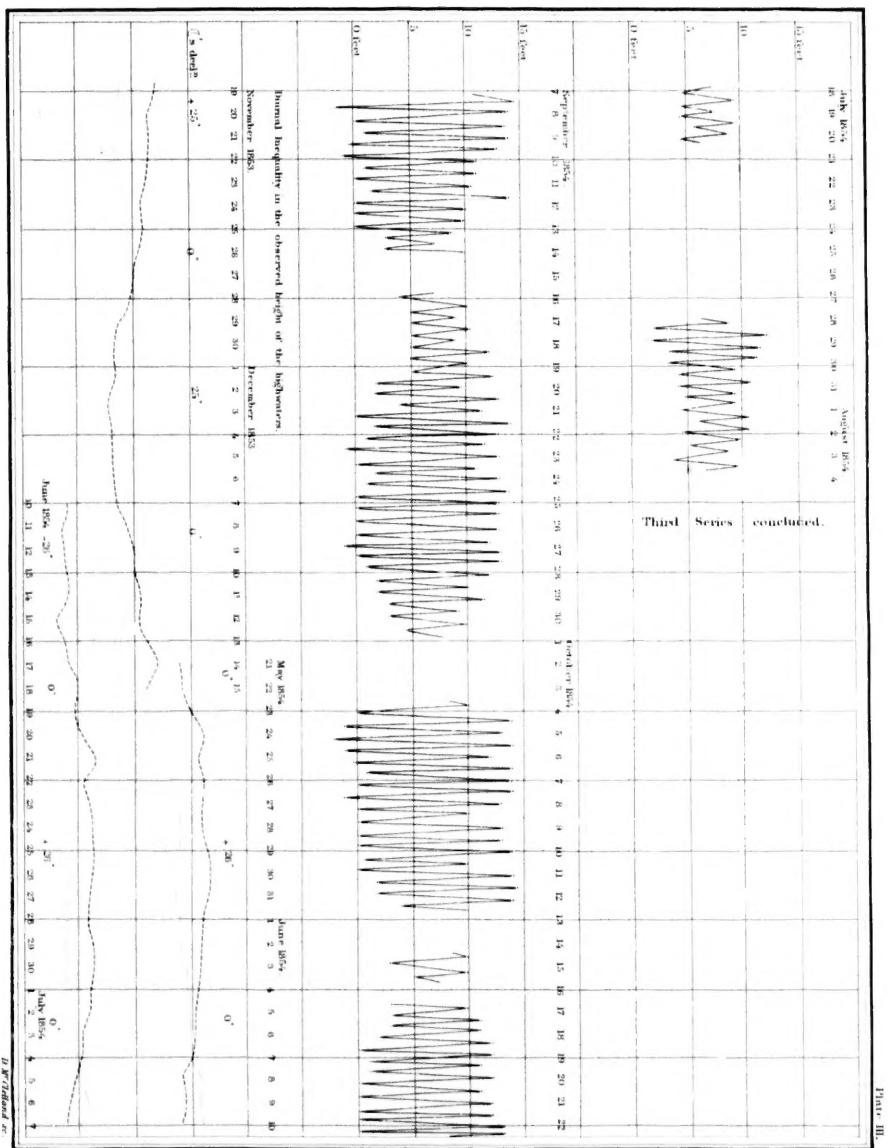
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60  
61  
62  
63  
64  
65  
66  
67  
68  
69  
70  
71  
72  
73  
74  
75  
76  
77  
78  
79  
80  
81  
82  
83  
84  
85  
86  
87  
88  
89  
90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100











To McCelland or

